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Engineering NEWS-RECORD

April 21, 1938

ANNUAL WATERWORKS NUMBER

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VOL. 120 *APRIL 21, 1938* No. 16

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Ray Goudey of the Los Angeles Water Department measures sun spots and radiation to help him decide when to get busy in combatting taste- and odor-producing algae in his reservoirs, p. 581. . .

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Fluoride removal costs may be considerably lowered by further development of the magnesium oxide process, p. 591. . .

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THE COVER PICTURE—Laying 36-in. Pedlar River water supply line to Lynchburg, Va.
C.M. & E. Staff Photo

Number of copies of this issue printed: 33,437

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THE WEEK'S EVENTS

New Spending Program Asked by President

Roosevelt urges Congress to provide $3,000,000,000 in loans, grants and relief to finance new program of public works

Asserting the need for increased purchasing power to meet the current business depression, President Roosevelt in a message to Congress April 14 urged increased sums for relief to the unemployed and an increase of $1,462,000,000 over budget estimates for a new program of public works construction. First response to the President's message came with the allocation of $4,445,649 by PWA for 70 school projects, the first PWA allotment in some months, and in a favorable report by the House appropriations committee on an appropriation for flood control even larger than the President had asked.

To meet the immediate needs of the unemployed, the President urged appropriations to carry on the activities of existing relief agencies. He asked that $1,250,000,000 be appropriated for the WPA to be used during the first seven months of the coming fiscal year. For the Farm Security Administration he asked $175,000,000; for the National Youth Administration $75,000,000; and for the CCC, $50,000,000 in addition to the previously budgeted amount of $230,000,000, in order to avoid a decrease in the number of camps. These latter appropriations are to cover the full fiscal year.

Public works

To finance a renewal of public works projects, the President asked the expenditure of $430,000,000 and authorization of loans of as much as $1,000,000,000 to states and their subdivisions. He recommended that sponsors have the choice of financing projects either by the previous PWA method of a 45 per cent grant and a 55 per cent loan or by a 100 per cent loan without interest.

The President recommended that "no loans or grants should be made on any state or local project which cannot be started in six months of the date of the enabling legislation, and completed within a year or a year and a half from the commencement of work."

Housing

In addition, the President asked that the U. S. Housing Authority Act be amended to permit immediate construction of about $300,000,000 worth of projects. This would presumably be in addition to the $500,000,000 which the U.S.H.A. is now authorized to loan over the next three years.

For highways, the President urged that $100,000,000 be appropriated to the Bureau of Public Roads in excess of the $100,000,000 previously budgeted for the fiscal year 1939. He requested that "this additional amount be used only for projects which can be definitely started this calendar year."

An appropriation of $37,000,000 over and above estimates is recommended for flood control and reclamation, to be expended on projects already authorized. The present budget calls for a flood control expenditure of $63,000,000.

The House appropriations committee on April 18 reported the non-military appropriation for the War Department with a total of $113,000,000 for flood control work, thus increasing the budget figure by $50,000,000.

In addition to these recommendations for relief and public works, the President announced his intention to "desterilize" about $1,400,000,000 of Treasury gold and to have the Federal Reserve Board reduce reserve requirements by about $750,000,000. These plans have already been carried out. In addition to this credit expansion, the President expressed his approval of the recent action of Congress in authorizing $1,500,000,000 of RFC loans to private business.

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Many PWA Projects Ready For New Program

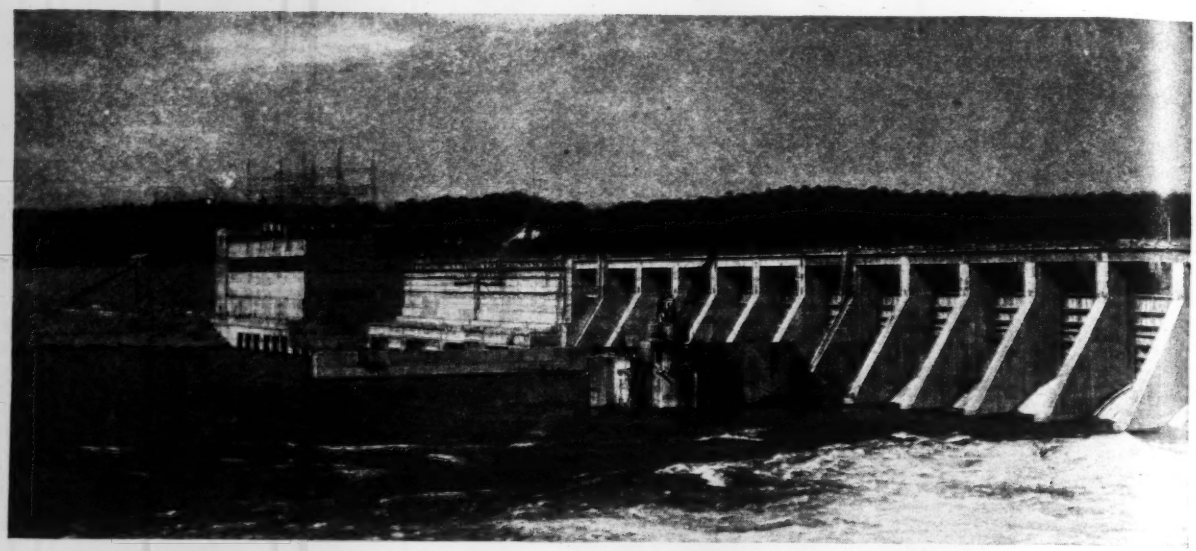
The Public Works Administration has a large reservoir of projects held over from previous programs which would make possible rapid allotment of money under a new program. Applications are on file already examined and approved, for about 2,800 projects calling for loans of $132,000,000 and grants of $443,000,000. The total cost of this construction is about $1,000,000,000. These applications have been prepared on a 45-55 per cent basis.

These are projects which were caught in an incomplete stage by the sudden cessation of the previous program. Most of them are understood to be ready to start work within 60 to 90 days, although a few may prove no longer suitable.

Allotments approved

Approval of twelve PWA allotments for schoolhouse construction was announced April 14. The allotments total $1,325,747, of which all are grants except for one loan of $175,000.

Four days later 58 more school projects were approved with allotments totaling $3,119,902. These projects also were taken from the list of applications received by PWA and approved by its examining division before June 29, 1937. The greater part of the allotments are for grants, only a few small loans being included, amounting to $175,500. PWA requires that the projects be substantially completed by July 1, 1939.



PICKWICK LANDING DAM NEARS COMPLETION

A RECENT VIEW of the TVA Pickwick Landing dam on the Tennessee River shows several of the spillway gates in position. The power house and switchyard are in the background.

Now in the final stage of construction, the dam will be 113 ft. high and 7,713 ft. long, and it will impound 807,000 acre-ft. in a reservoir reaching 50 miles up the river to the navigation lock at the lower end of Florence Canal below Wilson Dam.

Higher Truck Weight In South Carolina

The drastic limitations on weight and width of trucks in South Carolina were moved toward revision April 14 when the state House of Representatives passed a bill raising the limitations. The South Carolina truck regulations were held legal by the U. S. Supreme Court last February (*ENR*, Feb. 24, 1938, p. 284).

Both houses of the state legislature passed identical bills relaxing the stringent regulations. The Senate measure, however, is far down on the House calendar. The House bill was passed as an amendment to another measure and is now before the Senate.

Under this pending legislation, vehicle width is limited to 96 in. instead of the present 90 in. Total vehicle weight is limited to 40,000 lb. with axle loads set at 8,000, 9,000 and 16,000 lb., depending upon the type of tire. Trucks weighing more than 20,000 lb. are required to slow down to 20 miles per hour when meeting a vehicle from opposite direction. The height of a vehicle is limited to 12 ft. 6 in. and the length to 35 ft., including bumpers.

State and county highway authorities are authorized by the bill to reduce load, weight, and speed limits on bridges and highways where it is considered to be necessary in the interests of safety.

Other provisions of the new bill require that new motor vehicles, trailers, or semi-trailers built after July 1 must have service brakes on all four wheels. Auxiliary fuel tanks and tanks larger than 30 gal. are prohibited, and all vehicles more than 80 in. wide are required to carry two amber and two red clearance lights. Three lights are required if the vehicle is more than 30 ft. long.

• • •

More Flood Control Money In House Bill

An increase of $50,000,000 over budget estimates for flood control is provided in the appropriations bill for non-military activities of the War Department which was reported on April 18 by the House Appropriations Committee. The bill covers expenditures during the fiscal year beginning July 1.

A total of $113,000,000 is provided for flood control work, as compared with $105,000,000 for the current year. Of this sum, $31,000,000 is allotted to work on the Mississippi River and its tributaries and $82,000,000 to the general flood control program. An increase over budget estimates is also provided in the allotment for rivers and harbors of $94,300,000. This compares with a budget figure of $70,300,000, but it is less than the $128,000,000 which was appropriated for 1938.

The money is not earmarked for specific projects. It will be apportioned among authorized projects by the Chief of Engineers.

Increased Road Funds Passed by House

The House of Representatives on April 19 amended the Department of Agriculture appropriation bill for the fiscal year 1938-1939 so as to increase funds for road construction, and then passed the bill. Federal-aid payments were jumped from $63,000,000 to $125,000,000; other classifications of road construction and grade crossing elimination funds were also increased to raise the total appropriation from $100,000,000 to $201,500,000.

The action of the House Appropriation Committee last week in cutting nearly in half the provision for federal aid in the Department of Agriculture appropriation bill (*ENR*, April 14, 1938, p. 521) was not motivated, it is understood, by a desire to reduce road funds but arose from a matter of course acceptance of budget figures.

• • •

Last Committeeman Named For TVA Investigation

The last vacancy on the joint congressional committee to investigate TVA was filled April 19 when Vice-President Garner appointed Senator Davis of Pennsylvania. Although Senator Davis had previously expressed unwillingness to serve, it is understood that he has agreed to accept the assignment. He and Senator Frazier of North Dakota will constitute the Republican representation on the Senate side.

THE CURRENT TREND

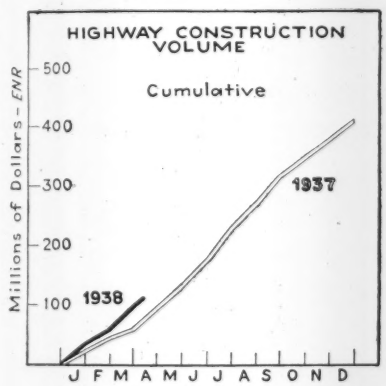
This week's news of contract volume and construction cost factors

Highway Volume Up

Highways gain 38 per cent over year ago, aid in boosting construction awards 19 per cent above 1937

Highway lettings for 15 weeks of 1938 total $113,400,000, a 38 per cent gain over the $82,300,000 reported for the corresponding period in 1937 by *Engineering News-Record*

Monthly statistics available through March, 1938, show all sections of the nation participating in the increase over last year, with New England recording a 73 per cent gain; Middle Atlantic, 59 per cent; South, 86 per cent; Middle West, 21 per cent; West of Mississippi, 13 per cent; and Far West, 85 per cent.



Highway lettings in New York State total $10,354,000 for the three months of 1938, 58 per cent above 1937; lettings in Ohio, $7,143,000, are up 186 per cent; in Washington, $5,374,000, up 269 per cent. Highway volume in Illinois, $9,513,000, and Texas, $4,928,000, are 12 and 39 per cent lower, respectively, than a year ago.

Construction volume up

Engineering construction awards for the 15 weeks of 1938, $777,709,000, are 19 per cent above the *ENR* reported volume for the corresponding 1937 period. Private construction, at $356,801,000, is 9 per cent higher, and public construction, at $420,908,000, is 30 per cent higher than a year ago.

Federal awards, $86,405,000, and state and municipal awards, $334,503,000, are 56 and 24 per cent higher, respectively, than last year.

The private gain over 1937 is due entirely to a 147 per cent increase in commercial building volume, while the public construction gain is due to a 38 per cent increase in highway lettings, a 16 per cent increase in sewerage awards; a 201 per cent increase in earthwork and drainage volume, and a 35 per cent increase in public building projects.

Business Briefs

INDEX OF SHIPMENTS of construction materials for February stands at 45, unchanged from January, but 24 per cent below February, 1937, as reported by National Resources Committee of the PWA.

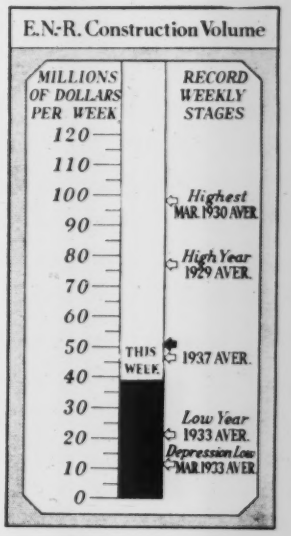
EMPLOYMENT IN PRODUCTION of six major construction materials based on 1923-1925=100, is 47.2 for February, unchanged from January, but 20 per cent under February, 1937, according to National Resources Committee of the PWA.

AMERICAN APPRAISAL COMPANY building cost index for February, 183, is unchanged from January, but is 5 per cent above the 174 reported in February 1937.

TERRA COTTA ORDERS for February, 1,136 short tons, are 27 per cent above the 893 tons for January, but 69 per cent below the 3,645 tons reported in February, 1937 by the Bureau of the Census.

PREPARED ROOFING SHIPMENTS total 2,286,730 squares for February, an increase of 25 per cent from January, but a decrease of 36 per cent from the shipments in February, 1937, as reported by the Bureau of the Census.

COMMON BRICK SHIPMENTS amount to 88,366,000 brick in January, 1938, 24.3 per cent below the December, 1937 figure according to the Bureau of the Census. Face brick shipments, 26,313,000, are 9.9 per cent lower; vitrified paving brick, 2,537,000, are 12 per cent lower; and hollow building tile shipments for January, 48,107 tons, are 10.1 per cent under December, 1937.



THIS WEEK'S FIGURES

(Thousands of Dollars)

CONTRACTS

	Week Ending Apr. 22 1937	Apr. 14 1938	Apr. 21 1938
Federal	$3,500	$4,393	$1,490
State & Municipal	20,387	21,468	24,170
Total public	$23,887	$25,861	$25,660
Total private	20,421	53,512	13,770
TOTALS	$44,308	$79,373	$39,430

Cumulative
1938 (16 weeks).....$817,139
1937 (16 weeks).....$695,753

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1937 16 Wk.	1938 16 Wk.
NON-FEDERAL	$474,667	$377,345
State & mun. bonds	174,652	198,530‡
Corporate securities	224,024	100,650
PWA loans, grants	46,852	−1,091‡
RFC loans	29,139	62,420
U.S.H.A. loans	.....	16,836
FEDERAL	.....	$86,532
TOTAL CAPITAL	$474,667	$463,877

‡ Represents transfer from federal to private investment financing through sale by RFC of PWA bonds.

ENR INDEX NUMBERS

Index Base	1913	1926
Construction Cost (Apr.)	237.95	114.38
Building Cost (Apr.)	198.21	107.15
Construction Volume (Mar.)	188.	82.

CONCRETE PAVEMENT YARDAGE awards for March are 24 per cent under March, 1937, as reported by the Portland Cement Association. Road yardage is 36.5 per cent lower; street yardage is up 14 per cent; and alley yardage is up 116 per cent. Cumulative yardage awards for the three months of 1938 are 32 per cent below 1937. Reported totals are:

	Square Yards Awarded March 1938	1938 3 months	1937 3 months
Roads	1,630,401	4,208,050	6,855,597
Streets	864,742	1,848,961	2,211,274
Alleys	63,472	108,966	41,359
Total	2,558,615	6,165,977	9,108,230

First Cement Bids On New Basis

Procurement Division receives bids to furnish all government cement for four months

On April 15 the Procurement Division of the Treasury Department opened bids for the first time under the new system by which the federal government is attempting to centralize cement purchases for all agencies of the federal government by procuring open contracts for four months on an f.o.b. mill basis with producers in all parts of the country.

Bids were submitted by 24 companies (many for more than one mill) offering to supply a total of over 7,500,000 barrels of cement at prices ranging from a low of $1.30 to a high of $2.29 per barrel (on a carload basis, unsacked). Inasmuch as the total government requirements for the period are estimated at about 3,000,000 bbl., this would appear to offer an ample supply. Analysis of the bids, however, indicated that real competition took place only in the Great Lakes and Pacific Coast areas, while there were large sections of the country from which no offers were received.

Bidding was negligible in New England, the Atlantic seaboard states, and the region between the Mississippi River and the Rocky Mountains. A complete tabulation of the potential sources of supply, the maximum amount offered by each, and the price in carload lots, unsacked, are given in the attached table.

It was officially stated that bids would only be received f.o.b. a manufacturing plant. However, at a number of the points listed in the table there are no manufacturing plants except those owned by companies not bidding. It would appear that bids f.o.b. storage point have been accepted.

Bids were also asked on high-early-strength, moderate-heat, and sulphate-resisting cements, but the returns in these classifications were even less satisfactory, only a few scattered bids being received.

Some refuse to bid

Eight major producers—Universal-Atlas, Lehigh, Lone Star, West Penn, Nazareth, North American, Penn-Dixie, and Alpha—declined to submit any bids upon the new basis. Although the government has refused to make the letters public, it is understood that most of these companies submitted, in writing, their reasons for refusing to participate.

The government's action in calling for bids on the new basis is the result of dissatisfaction with the basing-point system of pricing that has hitherto obtained in the cement industry. The industry has always contended that the only way in which competition can be assured is by quoting delivered prices. Because various brands of cement all meet certain specifications, the industry argues that quoting f.o.b. mill prices would soon result in a monopoly for each mill in its particular area, to the detriment of the industry and the public.

The new plan, it is pointed out, recognizes that the point of use is the real point of competition because, although the government asks for bids in 63 zones and sub-zones where mills are located, it expects to allocate orders without regard to such divisions, getting its supply for a particular job from that mill whose f.o.b. price plus transportation cost will total the least. Furthermore, the government does not promise to buy a single barrel from a successful bidder, but wants what amounts to an option for the four-month period that will permit it to buy as much or as little cement at the bid price as may prove convenient to it. Under such circumstances it would seem to be impossible to schedule production with any degree of certainty, and costs of production and storage would be highly uncertain.

Protests likely

Alarmed at the situation in the cement industry, manufacturers of other materials utilized in building construction, such as lumber, paint, and brick, are preparing a protest to the Procurement Division.

Another point at issue in the new plan is the provision that contractors on government-financed public works projects shall be permitted to purchase their cement requirements on the same basis as the government itself. General utilization of this privilege would short-circuit many sales now made through established local dealers and would disrupt present methods of cement distribution.

WHERE THE GOVERNMENT CAN BUY NORMAL PORTLAND CEMENT

Prices given are per barrel in carload lots, unsacked unless otherwise noted. Most bidders also offered to deliver in sacks at a slight differential.

	Amount	Price
New York		
Buffalo	400,000	$1.57
Oswego	200,000	1.63
New Jersey		
New Village	200,000	1.40
Pennsylvania		
Evansville	125,000	1.60
West Conshohocken	125,000	1.70
Ohio		
Cleveland	200,000	1.45
Toledo	200,000	1.45
Michigan		
Wyandotte	300,000	1.30
Bay City	200,000	1.45
Detroit	400,000	1.35
Detroit	100,000	1.70
Muskegon	200,000	1
Petoskey	150,000	1
Alpena	400,000	1
Saginaw	200,000	1
Wisconsin		
Milwaukee	300,000	1
Milwaukee	100,000	1
Milwaukee	**	2
Green Bay	80,000	1
Duluth	400,000	1
Illinois		
Chicago	**	1
Chicago	100,000	1
La Salle	**	1
Missouri		
Cape Girardeau	***	1
St. Louis	***	1
Iowa		
Mason City	Unstated	1
Tennessee		
Memphis	***	2
Indiana		
Speed	240,000	1
Kentucky		
Kosmasdale	100,000	1
Georgia		
Rockmont	200,000	1
Texas		
El Paso	200,000	2
Wyoming		
Laramie	70,000	1
Washington		
Irwin	25,000	2
Concrete	200,000	1
Seattle	150,000	2
Grotto	40,000	2
Billingham	20,000	2
California		
Calavaras County	200,000	1
Redwood Harbor	340,000	1
Cowell	90,000	1
Colton	300,000	1
Victorville	200,000	1
Monolith	480,000	1
Crestmore	400,000	1
Los Angeles	60,000	2

* In paper bags.

** Combined bid covering not less than 56,250 nor more than 93,750 bbl. from these three points.

*** Combined bid covering not less than 19,750 nor more than 31,250 bbl. from these three points.

• • •

6 Per Cent Utility Profit Held Sufficient

Under present economic conditions, 6 per cent on its investment is a fair return for a public utility to receive, it was held by the U. S. Circuit Court of Appeals for the eighth circuit in an opinion handed down April 13. The opinion denied an appeal of the Arkansas-Louisiana Gas Co. of Texarkana, Ark., which had sought an increase in gas rates.

The company appealed from a federal district court decision which had disallowed an order for a decrease in rates but refused to grant the company's request for an increase. The company contended that it was entitled to a return of 10 per cent on production facilities and 8 per cent on transportation and distribution facilities. The appeals court held a 6 per cent return not confiscatory.

The appeals court opinion quoted Chief Justice Hughes of the U. S. Supreme Court, who wrote that a public utility is entitled to rates which will permit it to earn a return equal to that from other investments attended by the same risks and uncertainties but has no right to profits such as are realized or anticipated in highly profitable or speculative ventures.

Rudy Arnold Photo

WORLDS FAIR RISES OUT OF FLUSHING MEADOWS SWAMP

ONE YEAR before the opening date of the New York Worlds Fair, Apr. 30, 1939, construction of many major buildings is well under way. This air view, looking north with Horace Harding Boulevard in the foreground, shows construction in the central part of the grounds. To the left, bordering on Grand Central Parkway, is the New York City building, the Business Administration building and the Fair headquarters. Prominent in the center are the Welfare and Production exhibition buildings. The Trylon and Perisphere, marking the Fair theme, are being built just to the left of these center structures. In the foreground foundations are being built for the amphitheatre that will face the artificial lake in the right foreground.

River and Harbor Projects Authorized in Bill

Authorization of 39 new river and harbor improvement projects with a total cost of $33,903,850 is contemplated in a new omnibus bill reported April 19 by the House committee on rivers and harbors. All projects included in the bill have been approved by the War Department.

The largest project included is a proposal to widen and deepen the Delaware River between Philadelphia and the sea to accommodate new naval vessels to be built at the Philadelphia Navy Yard.

• • •

Falls View Bridge Sinks in River

Nearly three months after it was wrecked by an ice jam in the Niagara River, the Falls View Bridge at Niagara Falls, N. Y., broke through the ice and sank to the bottom of the river on April 13. The bridge fell under the pressure of an ice jam on Jan. 27, and since that time has been lying on the ice.

Design of Bridges Changed On Merritt Parkway

Changes in plans for the construction of bridges along the Merritt Parkway in Connecticut have been announced by Highway Commissioner Macdonald. In accordance with the recommendations made by Charles J. Bennett, who investigated the parkway at the request of the governor (*ENR*, March 31, 1938, p. 451), the width of the three bridges that carry the parkway over highways in Fairfield and Westport, Conn., will be increased about 10 ft. Bids were received on these bridges several weeks ago. A separation strip about 8 ft. wide will be carried over the bridges, and the bridges will also carry a strip on the outside of each traveled lane, thus providing a shoulder for the highway.

Where the parkway is carried under bridges yet to be built, the spans will be 70 to 75 ft., about 10 ft. greater than have been used in the past. Two bridges, in Greenwich and Stamford, will cross the parkway with a span of 85 ft., so that both lanes will continue straight under the bridge without converging.

Tunnel Bids In For Shasta Dam

Eleven bids received on tunnel for railroad relocation and river diversion

Apparent low bid on the railroad relocation and river diversion tunnel at Shasta Dam, part of the Central Valley project in California, was submitted by Colonial Construction Co. of Spokane. Its bid was $426,000. Bates & Rogers Construction Corp. of Oakland was second with a bid of $484,000, and the eleven bids received ranged to a high of $640,000 offered by Clyde W. Wood of Los Angeles.

The 1,820-ft. tunnel will be used to carry Southern Pacific R.R. traffic through the west abutment of the dam site in the Sacramento River canyon while work proceeds in the canyon on the dam foundations. Later, when a new 30-mile railroad line around the reservoir site is completed, the tunnel will be used to divert the flow of the Sacramento River during the second stage of dam construction.

Reclamation commissioner Page announced last week that substantial agreement had been reached on nearly all phases of the Central Valley project problems involving the Shasta railroad relocation, water rights in the San Joaquin River, and rights-of-way in the Friant division. Agreement has been reached on all principal points with the Southern Pacific in regard to railroad relocation. The government, Page said, will perform the work of excavating, grading, tunneling, and bridge building for the new 30-mile line. The railroad will lay track and install signal systems and be reimbursed for this work on a cost basis.

Negotiations to purchase water rights from Miller & Lux at the appraised price of $2,450,000, are nearly completed, and tentative agreements have been reached which are expected to lead to action with respect to other interests with rights on San Joaquin.

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Time Extension Asked For Buffalo Sewer

The Buffalo Sewer Authority, of Buffalo, N. Y., voted on April 14 to ask PWA for an extension of time until Dec. 31 of this year to complete the $15,000,000 Buffalo sewer project. Under the original contract the work was scheduled for completion July 1.

Although the project is 95 per cent complete and it will be possible to begin operations on the scheduled date, additional time is required for a considerable amount of minor work.

Railroad Problems Passed to Congress

President sends special report on railroads to Congress without his endorsement

President Roosevelt, on April 11, passed to Congress without specific recommendations proposals for improving the present condition of the railroads made to him by a special committee of three members of the Interstate Commerce Commission. With the President's message and the report were letters commenting on the report prepared by the President's advisors on financial, legal and labor matters.

Changes proposed

The committee, consisting of Chairman Splawn of the I.C.C. and commissioners Mahaffie and Eastman, divided its recommendations into two parts, measures for immediate relief and those related to long-range planning. The former are largely financial and have to do with keeping railroads out of bankruptcy or with speeding the reorganization of those that are now in the hands of receivers. The committee would have the government make $300,000,000 available for the purchase of railroad equipment and would have the R.F.C. loan money to the railroads for bond-interest payments without the I.C.C. certificate that is now required. It would abandon the practice of giving the government reduced rates on land-grant railroads.

On long-range planning, the committee proposes setting up a Federal Transportation Authority with a life of from two to seven years to plan for and promote consolidation and coordination of railroads and to develop means of eliminating waste. The authority would be instructed to study other forms of transport with a view to eliminating wasteful competition. It also would report on the extent to which other forms of transport are subsidized.

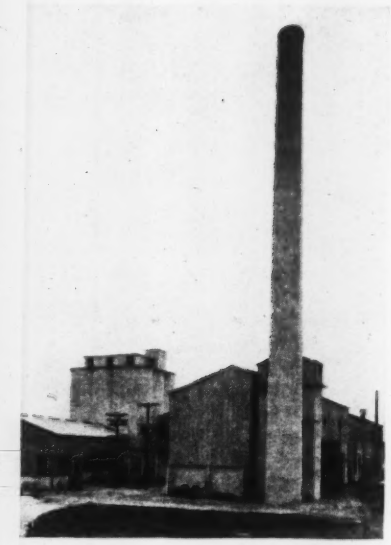
The committee proposes broadening the powers of the I.C.C. with respect to pooling of earnings and traffic. The so-called "consolidation plan" now in the Interstate Commerce Act would be eliminated and in its place the I.C.C. would be given power to approve such unification as it found to be in public interest.

New federal department

The committee states that the logical outcome of setting up a transportation authority and expanding the powers of the I.C.C. would be the establishment of a new federal department to take over all functions relating to rail, water, air and road transport now exercised by several federal agencies. On this point the President disagrees. He would separate executive functions from quasi-judicial, putting the former in one of the existing departments and leaving the latter to the I.C.C.

Rate change disapproved

Since the President sent his message to Congress the Interstate Commerce Commission rejected the plea of the eastern railroads for an increase of one half cent in the passenger rates. The railroads estimated that the increase would have increased their income by about $30,000,000. In dissent from the majority opinion commissioners Eastman and Mahaffie, both members of the President's special committee, took the view that if the railroad managers are willing to take the risk of driving away traffic by increasing rates, the I.C.C. should not overrule them.



NEW CEMENT PLANT OPENED

SAID TO BE the only cement plant built in the United States during the past year, the new Houston plant of the Gulf Portland Cement Co. got into production early this month.

The half million dollar plant will have a daily capacity of 840 barrels. It will manufacture standard portland cement.

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Oregon Power District Defeated by Voters

Public ownership and operation of power distribution facilities in a section of Oregon was defeated April 8 when voters in the proposed seven-county public utility district turned down the proposal to create the district by a vote of about 13,000 to 21,000.

New York City Raises Contract Wage Rates

The wage rate schedule which contractors holding contracts from the city of New York must maintain has been sharply increased under new regulations announced April 12 by the city controller. City law requires the controller to determine prevailing wage rates in the city and to draw up a schedule on that basis. The new schedule "which is the result of three months' study . . . reflects actual conditions in existing contracts," the controller said.

On 87 classifications the existing rates are continued and in 28 other classifications the rate is increased. In only one case, that of decorative glass workers, is the schedule lowered, hourly wages in this classification being reduced to $1.50 from the previous figure of $1.65.

The following table shows typical changes in hourly rates in those schedules which were increased:

	New rate	Old rate
Electricians	$2.00	$1.70
Engineer (operating)		
Asphalt plants	1.75	1.50
Compressor, stationary	1.92½	1.87½
Concrete paving mixer	1.92½	1.75
Hoisting engine	1.92½	1.87½
Locomotive (Diesel and gas over 10 tons)	1.92½	1.87½
Plumbers	2.00	1.75
Miner drill runners	1.87½	1.75
Engineers (hoisting)	2.20	2.00
Glazier	1.88½	1.65
Machinists	1.75	1.40
Millwrights	1.75	1.40
Mosaic and Terrazzo workers	1.75	1.50
Tile layers	1.68¾	1.56¼

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New TVA Test Asked In Supreme Court

A new test of the constitutionality of the Tennessee Valley Authority was asked of the U. S. Supreme Court on April 18 when eighteen utility companies located in the vicinity of the TVA area appealed the recent decision of a three-judge federal district court upholding the agency. They charge that TVA activities violate the constitution in numerous ways and threaten irreparable injury to all privately-owned utilities which are operating in the area.

Because of the magnitude of the case it is doubtful whether a decision can be rendered during the present session of the court. It is estimated that the record of the lower court's action, which must be printed, will total almost 10,000 pages in addition to thousands of maps, rate schedules, and other exhibits. The present schedule of the court calls for final oral arguments on May 2 and for adjournment by about June 1.

Revised Wage Scales Delay Arkport Dam Bids

Opening of bids for the Arkport Dam on the Canisteo River near Hornell, N. Y., was postponed from Apr. 15 to Apr. 20 by the U. S. District Engineer at Binghamton when the federal department of labor decided to revise the scale of wages certified as "prevailing" for the work which was undertaken last winter.

At that time bids were contemplated for the spillway and diversion tunnel only, and the dam was to be let later as another contract. However, plans were revised to include the whole project in one contract to be awarded under bids to be opened April 15. Two days prior to the opening the army engineers received from the department of labor a new set of wage scales averaging about 15 per cent higher than the previous rates. A postponement of the opening was therefore necessary. Arkport Dam is the first of a series planned for flood control on the Susquehanna and its tributaries in southern New York. It will contain 850,000 cu. yd. of rolled earth fill.

Following are the old and new rates as certified by the labor department as prevailing and therefore to be considered as minimums to be paid under the contract.

ARKPORT DAM LABOR RATES

	New Rates	Old Rates
Welder	$1.20	$1.00
Blacksmith	1.00	1.00
Compressor oper. (160 ft. or under)	.75	.75
Compressor oper. (over 160 ft.)	1.00	.75
Batcher plant oper.	.55	.55
Bulldozer oper.	.65	.65
Carpenter	1.00	1.00
Cement finishers	1.375	..
Cement finisher asst.	.65	.65
Crane oper.	1.375	1.125
Concrete mixer oper. (under 14S)	1.00	.60
Concrete mixer oper. (14S or over)	1.375	1.00
Clamshell oper.	1.375	1.125
Dragline oper.	1.375	1.125
Electrician's helper	.60	..
Electrician	1.00	.90
Hand rock driller	.75	.75
Labor, common	.50	.50
Labor, concrete puddler	.60	.60
Mechanic (heavy equipment)	1.00	1.00
Oiler	.75	.75
Piledriver oper.	1.375	1.125
Pump oper. (portable)	.75	.65
Powder man (blaster)	.75	.75
Reinf. setter	1.35	1.25
Shovel oper.	1.375	1.125
Tractor oper.	.65	.65
Truck driver	.55	.55

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State Held Responsible For Road Obstruction

The Connecticut highway department commission was held liable for damages caused to a truck when it collided with a privately owned stairway, the bottom step of which projected onto the shoulder of a state highway. The Connecticut superior court awarded damages of about $1,000 to Short Line Associates, Inc., and held that the abutting property owner was not liable. The court held that the obstruction had been in the highway long enough for the highway commissioner to have notice of its existence.

The steps were located on an 18-ft. concrete road in Berlin, Conn. The bottom step projected over the edge of a 4 ft. oiled shoulder. The accident occurred in June, 1934.

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Congress Will Act Soon On Fort Peck Power

Congressional action on a pending bill providing for power development at the Fort Peck Dam project on the Missouri River before adjournment was pledged by House leaders on April 18. Rep. O'Connell of Montana forced the issue by objecting to a proposal to pass the bill over without action when it came up on the calendar. Majority leader Rayburn thereupon assured Rep. O'Connell that the bill would be brought up later, under suspension of the rules if necessary, in order to reach a vote before adjournment.

The bill would authorize the development and utilization of hydro-electric power at the Fort Peck Dam, with an ultimate installation of about 105,000 kw., at an estimated cost of about $6,750,000, development to proceed as rapidly as a market for the power can be assured.

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Court Asked to Pass On PWA Power Loans

The Tennessee Electric Power Co. on April 15 asked the U. S. Supreme Court to review a lower court decision refusing to enjoin a $4,330,000 PWA loan and grant to the city of Chattanooga, Tenn., for the construction of a municipal electric system. The three-judge district court dismissed the suit on the ground that the validity of the allotment was established by the Supreme Court decision handed down early this year in the Alabama Power Co. and Duke Power Co. cases.

In appealing the decision to the U. S. Supreme Court, the Tennessee Electric Power Co. claims that the franchise under which it now serves the Chattanooga area differs materially from those in the previous case. The company's energy is derived from the Hale's Bar Dam, chartered in 1906 by Congress.

Separating Floodways Is Recommended

Senate committee approves separate construction of Morganza and Eudora floodways

A proposal to change the present law so as to release the recommended Morganza floodway from the provision that links its construction with that of the Eudora floodway has been reported favorably by the Senate Committee on Commerce. The amendment to the flood control act would also allow the Chief of Engineers full discretion in determining the level at which the Morganza floodway would discharge. The present law prescribes that it must not be used until a stage of forty-nine feet is reached on the Angola gage.

Interests in the Yazoo basin are opposing the amendment actively. They think their only hope of securing a diversion at Eudora is to continue the requirement that there be two floodways or none. This is characterized by the Louisiana interests as the use of Morganza as a club over landowners in the path of the Eudora floodway who refuse to sell flowage easements.

Mississippians claim, and Major General Julian L. Schley, the Chief of Engineers, agrees with them, that another flood of the volume of that of 1927 (2,400,000 sec.-ft.) cannot be carried between the levees from the Arkansas River to Red River. Brig. General Harley B. Ferguson's statement that 2,600,000 sec.-ft. could be carried between the levees when Morganza is built and the bottle-neck at Natchez widened was characterized by Gen. Schley as a more optimistic estimate than any other member of the corps would make. He admitted that the need for protecting the Atchafalaya basin is more urgent than the need in the middle sector.

The necessary flowage options have been secured for the Morganza diversion. It could be completed with the expenditure of $20,000,000 by the end of the year, Gen. Schley testified. In answer to questions by members of the committee, Gen. Schley said construction of the Morganza floodway would help Louisiana greatly and would not harm Mississippi. Mississippi witnesses asked that the government condemn the necessary land and proceed with the Eudora along such structural lines as the army engineers determine.

The Senate is expected to pass the amendments reported out by the commerce committee. The legislation, which has the approval of the Chief of Engineers, faces difficulties in the House.

New continued on page 597

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Simplify Concrete Column Formulas

Sir: Your issue of March 3 noted that the American Concrete Institute proposed, among other things, further changes in the column formula for eccentrically loaded columns. Let us hope that this results in a simplification of the present monstrosity to a workable formula for design purposes. The present formula may fit perfectly with test results and theoretical analysis, but is such hairsplitting consistent with the approximation in the assumptions as to loads and properties of the materials? Such a formula is a wonderful mental exercise and is valuable in the classroom, but in the design office — "Aw, hell, let's make a steel frame job out of it!"

Another thing: In the ordinary building frame, where the maximum column moments occur at the floor levels where there is lateral support, is there any reason why the maximum concrete stress in the columns should not run as high as the allowable stress in continuous beams of the same grade of concrete?

BRUCE M. DACK
Sacramento, March 8, 1938

Getting the Best

Sir: In connection with the present and past era of new building of bridges and theatres in the United States, permit me to draw attention to the arrangement existing in many other countries. This scheme eliminates errors in judgment and design, and permits the choosing of the best structure.

A special jury of prominent engineers and architects is appointed through the initiative of interested groups and under the auspices of engineering societies and universities and with the help of representatives of the leading technical periodicals in the field.

This commission publishes outlines of competitions for the new buildings, establishes the prizes in their graded order and fixes the terms for presentation of designs to the jury. In a year or so, the jury publishes its findings in the technical periodicals, and sometimes in the daily press.

This method has the following advantages: A great deal of the casual choosing of type of location and design of structure is avoided; a jury composed of really best authorities excludes the errors; many unknown American and foreign geniuses get a chance. A population which spends hundreds of millions in building can certainly afford a few hundreds of thousands of dollars for organizing a jury and for the prizes.

For example, by approximate estimate made in 1928 showed that such an arrangement for choosing a design and location for a new Hudson River bridge within the city limits and a new Metropolitan Opera House would be about $250,000.

A price awarding jury for smaller project like Niagara Falls Bridge for instance, would cost still less.

ALEXIS COUNT DE LANZY
Brooklyn, N. Y.

Elevated Highway Designs

Sir: Reflecting upon the recent elevated highway competition, I would like to submit the following comment, which might be of interest to the readers of the *Engineering News-Record* in regard to the structure which was awarded first prize.

Leaving out of this discussion the architectural and structural merits of this project and regarding only the traffic possibilities provided, it is noticed that a larger portion at the center of the surface roadway has been blocked by supporting structures. Judging from the published reproduction of the perspective, it would appear that this reduction of effective traffic section would exceed one lane. Now realizing that some place along the roadway two parallel ramps for ingress and egress will further obstruct the traffic space to the extent of at least one traffic lane plus the width of two curbs for each ramp, it is seen that the reduction of the surface road will just about offset the four lanes provided by the proposed elevated road.

It would seem that a structure having supporting members confined within the lanes required for ingress and egress would solve the traffic problem more satisfactorily, as in this case four safe unobstructed lanes would be available on both of the two elevations.

BERNARD HOLMEN
Jackson, Mich., April 9, 1938

Chickamauga Dam Foundation

Sir: On page 667 of the Engineering News-Record for Oct. 21, 1937, appears an article on the foundations of the Chicagamauga Dam. This structure was to be placed upon a limestone containing many caverns and fissures which were to be carefully grouted. I wish to ask:

(1) Will not some percolation still be probable? I consider that it is impossible with head existing at the Chickamauga Dam to make dam even approximately watertight.

(2) Will not the rate of percolation be large under the foundations of the dam? Here the water has its shortest path between two bodies of water under a difference of head which is approximately constant.

(3) Will there not be a rapid dissolution of the limestone rock wherever there is percolation? Living as I do in a limestone district I feel sure that this question must be answered in the affirmative.

(4) What effect will this have on the foundations of the dam?

(5) Would you consider this a safe dam to erect just above a large city?

HORACE R. THAYER
Pennsylvania State College
State College, Pa.

Sir: In reply to the inquiry about Chickamauga Dam:

Comments on questions 1 and 2 may be combined. Almost the entire area on which the dam is being constructed has one or more layers of shale and bentonite. Below the uppermost layer, where it has a reasonable covering of rock, we have found no cavities or solution channels. If the uppermost layer occurs close to the surface and has been broken through by weathering, the second layer or bed limits cavitation. With the occurrence of these beds as a guide, we treat the foundation ac-

cordingly, which means a very intensive grouting program.

In the lock and spillway so far constructed, we have excavated to the proper bed of shale for starting concrete. In the spillway section particularly we found no seams or joints and no cavities. Very few holes took any grout at all, although fairly high pressures were used in the deep drill holes.

In order that no vertical joints would be missed, we drilled our cut-off holes (40 ft. deep) at an angle of about 25 deg. in the plane of the grout curtain, and check holes were drilled and grouted in the opposite direction in the same plane, resulting finally in a criss-cross pattern. These holes were 5 ft. on centers. The powerhouse excavation will generally be as good. In other words, this rock is as tight as any rock could be, below the shale and bentonite beds.

Abutment foundations

This then turns the question to the probable conditions under the abutments, where earth fill is used across the flood plain. In these sections we excavate the overburden to sound rock, that means we strip off the loose boulders and clean out open seams. The shale bed is traced out by diamond drills, and, except for a few hundred feet on the south end of the south earth dam, we have located one of the beds at depths varying from 10 to 80 ft. below the rock surface. It is in this section, above the shale, that seams, joints and cavities are found, and here the foundation treatment is most intensive. When finally completed, a hole has been drilled every 12 in. and grouted. In some instances the spacing has been closer. Where vertical jointing occurs the holes are inclined.

Frequent holes, on not to exceed 25-ft. spacing, are drilled to and through the shale bed and these are grouted using higher pressures. The depth of cavitation seldom exceeds 40 ft. except where faults occur. In following out the above drilling procedure all cavities are located. The method of cleaning them out varies with the depth and other conditions, but they are all concreted for a width of 5 ft. up and downstream and for their entire length in the plane of the cut-off. The section is then redrilled and thoroughly grouted, covering every foot along the cut-off line. In all of the foundation treatment the holes are washed in such a way as to clean out all small seams so that they may be refilled with grout. The holes are drilled first on 4-ft. centers, then washed and grouted. Next holes are drilled midway between these and washed and grouted. This is repeated in two more steps, to reduce the final spacing to 12 in., above referred to. Thus, we not only drill check holes but we double and treble check them. If this is not enough, more holes are drilled or the material is excavated and replaced with concrete, and again regrouting is done. In view of the above, it will be seen that we are trying to eliminate entirely any percolation.

While the Chickamauga site is a difficult one and offers, at places, channels for percolation, very thorough treatment has been given to the foundation—so thorough that we believe that we are warranted in stating that percolation under the foundations of the dam is practically eliminated. The excavation in the spillway, lock, and powerhouse is carried down to the bottom of a bentonite bed, which, in combination with the tight concrete of the dam and with the thorough grouting of the underlying rock, will substantially eliminate any percolation. Under the earth portions of the dam, as stated, the rock has been exposed and cutoff operations have been conducted in it so as to definitely seal the rock for a depth of 40 ft. from its surface.

As to question 3, dissolution of limestone will occur if percolation occurs for a sufficiently long time and if the waters carry in solution material quantities of carbon dioxide. Dissolution of limestone rock is a rapid process geologically—measured in thousands and millions of years—but measured in time known to man it is extremely slow. For instance, there are many tombstones and monuments in this country over one hundred years old made of the purest crystalline limestones (marble) which have not dissolved greatly in that length of time. The best concrete is several times more soluble than any limestone at Chickamauga Dam. We believe that percolation is so effectively prevented by the measures taken that solution of the limestone under this dam will take place to only negligible extent.

We would say that with the precautions taken as outlined above we do consider this structure a safe dam to be built above a large city.

CARL A. BOCK
Assistant Chief Engineer
Tennessee Valley Authority
Knoxville, Tenn.

Nicaragua Canal

Sir: This is not a brief for or against the Nicaragua Canal, but I desire to take exception to certain statements and assumptions in Mr. Smith's letter. (*ENR*, April 14.) The basic assumption is that a sea-level canal would be less vulnerable to attack than a summit-level canal and of course this is open to argument. The assumption that it is possible to cut the Panama Canal down to sea level without locks is completely answered by the fact that there is a tide range of twenty feet on the Pacific side and that a tide lock would be necessary in a sea-level canal to prevent current velocities in the canal that would be obstructive to shipping. In addition, no satisfactory solution has ever been offered to the control of the flood waters of the Chagres and other tributary streams in any plan for a sea-level canal. As to the defense argument, it seems to me that a sea-level canal would be more vulnerable to air attack than a summit-level canal. The tide lock would certainly be just as vulnerable as the summit locks and the narrow channel of the Culebra cut would be more vulnerable than it is now. There is no reason to suppose that the anti-aircraft defenses of the canal are not adequate, but if it is impossible to defend the existing canal against air attack of a suicide squadron it would be just as impossible to defend a sea-level canal against the same kind of attack. Mr. Smith concludes, "the time saved by the passage of a sea-level canal would offset the shorter distance by Nicaragua." He ought to look at his atlas. The length of the Panama Canal from deep water to deep water is about fifty miles. The length of the Nicaragua Canal from ocean to ocean is 187 miles.

ROBERT ISHAM RANDOLPH
Riverside, Ill.
April 16, 1938

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WHENEVER we say "pure as water" we pay unconscious tribute to the waterworks profession. Since pure water is a processed product its quality is dependent on the exercise of technical skill coupled with high personal integrity on the part of the producer. Those in the service of supplying water and making it safe for consumption have reason to be proud of their achievements, but this pride would be hollow were it not sustained by a continued desire to strive for further perfection. It is a happy thought, therefore, to reflect that year in and year out this journal and others can consistently report advance in water processing. For despite almost universal faith in the purity of water, the profession is ever aware that it cannot relax its efforts in providing dependable safeguards. Among matters currently claiming attention are those concerned with mysterious gastro-intestinal disorders believed to be water-borne, removal of fluorides, and elimination of cross-connection hazards. The intestinal disease investigation is baffling, and as yet has not progressed to useful conclusions; the problem of fluoride removal is farther along, for its successful solution is imminent; and at long last cross-connection elimination programs are being vigorously promoted. Such progress in purification personifies the activity of the profession in carrying out its responsibilities, and justifies the belief that "pure as water" will forever remain the accepted standard of excellence.

Sunspots and Profit

STUDENTS OF SUNSPOTS and their relation to human affairs will have something tangible with which to prove their theories after reading R. F. Goudey's article on p. 581. Mr. Goudey is a practical waterworks man, and when he measures sunspots he does so with an eye to money. Looking for a more effective way of combating taste- and odor-producing algae in the reservoirs of the Los Angeles water system, he came to the conclusion that there is a correlation between ultra-violet radiation and algal growth. Accordingly he observes radiation along with sunspot activity, and when the ultra-violet rays reach a certain intensity he knows that shortly thereafter the algae will be at their best both in numbers and potency. Forewarned of the coming onslaught, he begins dosing the reservoir with copper sulphate. Taste and odor troubles are checked before they start, and the cost of chemicals is reduced by 20 per cent. Perhaps other waterworks men will find it profitable to do a little stargazing.

Continue the Work!

RESTORATION OF ROAD FUNDS is a significant item of the increased governmental construction by which the President proposes to revive business. Only a few months ago he urged that one whole year's federal aid be cancelled, and even after Congress declined to accept the reduction he asked the states not to use the road money already allocated until Congress reaffirmed its position. Now he reverses this attitude; to do otherwise would hardly be reasonable when proposing the expenditure of some billions of dollars for pump-priming. But the new friendliness to roads is a concession to an immediate emergency rather than recognition of the importance of fostering improved road service. That is all that can be read into the President's message. Accordingly, if the principle of federal aid and guidance to highway development is to remain a vital force it will have to be through the force of public opinion. The administration's temporary acceptance of an adequate road program does not warrant any letup in active work for continued federal highway aid on a scale commensurate with the magnitude of the problem.

Private Housing Gets a Hand

ANNOUNCEMENT by the Metropolitan Life Insurance Co. that it is planning a 120-acre low-cost housing development in New York City is news of first magnitude. Business and the country generally will welcome the fact that $35,000,000 to $50,000,000 is to be spent for materials and wages, and that 12,000 to 20,000 housing units are to be provided in a city that has several times this number of houses unfit for habitation. It is significant also that the development is being competently planned as a modern community fully equipped with parks, schools and stores. As the first application of a new state law permitting insurance companies to invest in housing enterprises, the project has a leading place in the day's news. Its cost is to be limited to $1,000 a room—$250 less than the figure that Congress recommended to the USHA for *subsidized* housing; yet the Metropolitan states that its project is a sound investment without subsidy. If private business methods can be seriously applied to the problem of low-cost housing, we may yet make progress in a field that has suffered much at the hands of public housers.

Help for the Railroads

EMERGENCY MEASURES designed to help the railroads over their present difficulties were placed before Congress by the President on April 11. The proposals, prepared by a three-member committee chosen from the Interstate Commerce Commission, provide for establishing a Federal Transportation Authority to plan and promote railroad economies, but not to take any positive action. Their very indefiniteness deprives them of value and removes the hope that they will help.

The committee's report also deals with fixed charges, bankruptcy procedure, consolidations, pooling of traffic, subsidies to roads and shipping, and government regulation. Unfortunately, throughout its report the committee says little about the railroad rate structure, and that little fails to indicate that the basic trouble of the railroads lies in the upsetting of the rate structure.

Our country was built up and its markets were expanded on a rate system based not on cost of service but on what the traffic would bear. Low-grade commodities moved great distances at less than cost, while high-grade commodities were made to pay the cost of this method of expanding markets. But now the motor truck has come along to skim off the high-rate traffic without taking its share of the movement of bulk freight. Here is one of the fundamental economic difficulties of the railroads; only direct, positive action can deal with it.

Congress should set up a Transport Authority as the committee proposed, but in the person of a single Director-General rather than a TVA-like board. It should be more than an investigating and plan-making agency; it should have the power and duty to order changes in rail, motor, air and water transport rates and to order consolidations of railroads, joint use of facilities, pooling of services and the like. The powers of the I.C.C. would be correspondingly curtailed to factfinding and to review of such rate questions or financial matters as the Authority might refer to it.

No less important, the railroads should be given back the managerial functions that Congress and the I.C.C. have nibbled away over a period of years. They also should be represented among the advisers of the Transport Authority—not only to enlist their support and cooperation but also to give them a chance to demonstrate that the initiative that built our great railroad system is not a thing of the past.

Keeping the railroads solvent is a major problem, but keeping our whole transport system truly solvent and capable of developing to meet our ever changing needs is more important. Millions of dollars of useful work and a vast amount of employment depend on the latter. Under such circumstances the nation should not be bound by antiquated laws or out-dated policies. The legislative slate should be wiped as clean as possible, permitting the new transport authority the broadest possible scope in rebuilding our transport system.

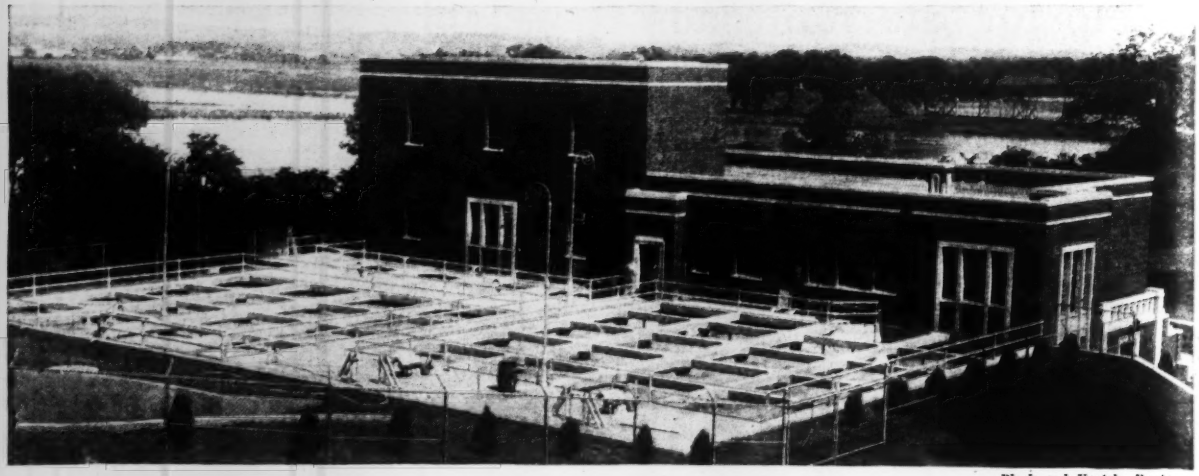
Revival of PWA

UNDER CONDITIONS of business and finance diametrically opposed to those of five years ago, when the Public Works Administration was set up to stimulate recovery through local public-works construction, the PWA system is to be revived as part of a two to five billion dollar spending program—so the President proposes. The purpose is to build up national income from the 50 billion dollar level to 80 or 100 billions, which would mean prosperity and a high standard of living for all. Elements of the program are loans to small business, moderate increase in federal public works, and activation of local public works to the amount of possibly one billion dollars through a subsidy, the latter being either a 45 per cent free grant, or a 50-year remission of interest.

Just how this program will build up national income as intended remains a mystery. Little is to be expected from the business loans, since their success depends on a confidence in the future that has patently been lacking. The important thing, therefore, is to make the best possible use of the new PWA program. There are now in the files of the PWA at Washington approved applications for local public-works projects whose total cost approximates a billion dollars. These projects applications are expressive of public needs—for schools, sewers, thoroughfares, and the like—whose satisfaction would benefit the whole community and whose construction would provide employment and stimulate business.

A favorable result, however, depends on quick and energetic action by Congress in enacting the necessary authorization. It is important, moreover, that the existing PWA organization, trained and ready for action, be placed in charge of the new program, to eliminate the delay and disorganization of establishing a new agency, and that the original financial setup be retained in place of the fantastic 50-year no-interest plan.

Furthermore, it is vital that a clear line of demarcation be drawn between the field of gratuitous public-works construction through WPA relief work and the new PWA program. The WPA has entered far into work that is unmistakably a local responsibility; this course needs to be stopped, if self-government is to survive. At the present time above all, when every city is trying to set its financial house in order, national recovery efforts should assist rather than check this process of rehabilitation. An aggressively conducted PWA program based on sound procedure can do so.



Black and Veatch, Engineers

FIG. 1. IRON REMOVAL AND WATER SOFTENING PLANT AT FORT LEAVENWORTH, KANSAS

Looking at Today's Problems

PAUL HANSEN

Greeley & Hansen, Consulting Engineers, Chicago

Attention is being focussed on new techniques in treatment, water-borne disease prevention, corrosion control, and aids to distribution efficiency

EACH YEAR brings certain problems of water supply into sharp focus. During the recent depression years thought centered primarily on items that bring about improved economy. When considerable impetus was given to the development of water purification projects by federal financial aid, attention was centered upon improved design and better equipment as well as less urgent matters involving removal of minor turbidity, color, taste and odor, iron, magnanese and hardness. Attention today is centered primarily upon improved operating technique, gastro-intestinal disease problems, corrosion control, aids to distribution efficiency, and removal of fluorides. Other problems relating to water purification have by no means been neglected, however, and some progress may be reported in nearly every department.

New construction stimulated by federal aid still continued active during 1937. In service now are 2,120 municipal filtration plants, of which only 17 are of the slow-sand type. The combined nominal capacity of these works is 7,500 m.g.d. The 141 municipal installations placed in service during 1937 compares with 200 for 1936, and the total capacity of 204 m.g.d. compares with 300 for 1936. Most of the installations, 76, were financed with PWA aid, 20 had WPA aid, 8 had no federal aid and for the remaining 33 the method of financing is not reported. Illinois, with 20 installations, topped Ohio, next largest, with 17. Six states reported no installations other than for chlorination. In the whole country 125 installations were made for sterilization only; of these 77 were for treatment of groundwater supplies and 48 were for treatment of surface supplies. The relatively large number of installations for treating groundwater reflects the sanitary unreliability of such supplies.

PURIFICATION WORKS PLACED IN OPERATION IN 1937

Type of Works	Number	Capacity M.G.D.
Filter plants for surface waters	70	119,300,000
Zeolite softening plants	11	5,900,000
Lime-and-soda softening plants	19	38,400,000
Iron removal plants	29	32,000,000
Softening and iron removal	12	9,100,000
Totals	141	204,700,000

Perhaps the major improvement in technique of operation relates to the application of chemicals to the water to be treated. Dry chemicals are being applied more accurately through improved feed equipment. Machines that measure by weight rather than by bulk are coming into increased favor. Vibrator feeders are also gaining in popularity because they tend to induce a more positive flow of the chemical by preventing clogging in storage hoppers and in feed-control mechanisms.

Coagulants must be in solution when applied to get most effective results. The weaker the solution the easier it is to get dispersion, therefore the more effective will be the reaction and the more perfect will be the subsequent flocculation. In recent installations much larger dissolving boxes equipped with stirrers are used in connection with dry-feed machines.

Coagulants and coagulant admixtures are receiving active attention. At St. Louis and Racine operators

are trying out silicates on a full plant scale. The use of silicates with usual rates of filtration, may not show material economy, but the stronger floc produced may permit the use of coarser sand and higher rates of filtration. No plants have as yet adopted bentonite (a colloidal clay) as a normal coagulant, but good results are reported at Atlanta. At Hammond it was considered for taste and odor control but the results of small tests were not reassuring. The sludge was bulky and economy was not apparent. While it proved more effective in this respect than other coagulants, its merits were not regarded as sufficient to warrant its use.

Carbon use increasing

Activated carbon is being more extensively applied and operators are becoming bolder in using larger quantities to remove tastes and odors. Some plants use more than 500 lb. per m.g. for short periods to combat extremely bad conditions. The general acceptance of the use of activated carbon will no doubt lead to the installation of granular carbon units as used for demonstration purposes in Chicago. A number of cities have already adopted it, notably Oshkosh and Neenah, Wis.

Granular carbon units may find a field of applicability in connection with unfiltered reservoir supplies which are of good sanitary quality but are subject to tastes and odors due to organisms. At Portland, Me., magnetite filters are used for alga removal. Perhaps such filters followed by carbon units may prove economical for treating waters occasionally infested with algae, but which are otherwise of good quality.

Chlorine feed equipment is being constantly improved and recently machines of very large capacity have been developed. Where large quantities of chlorine are used, the water for making the solution becomes so great as to be an object of economy measures. Accordingly the newer machines are equipped to regulate automatically the solution water in proportion to the quantity of chlorine being fed. While there have been no new installations of importance, interest and confidence has increased in the equipment for automatically controlling the feed to maintain a fixed residual chlorine as used at Los Angeles.

An elusive remnant exists of what appears to be water-borne intestinal disturbances. The more serious outbreaks are related to cross-connections, sometimes in the waterworks plant itself, but more often in the plumbing of buildings. The epidemic of amoebic dysentery in Chicago in 1933, traceable apparently to cross-connections has increased the alertness of waterworks and public health officials to these dangers. An educational effort is being conducted by master plumbers to prevent cross-connections.

No doubt some intestinal infection is attributable to inadequate purification, more especially in the smaller plants. This deficiency emphasizes the importance of having competent technically-trained personnel in charge of water purification processes;—men who can be relied upon to insure good water leaving the plant. A little carelessness or incompetence may result in disease and death for many. The responsibility of the waterworks operator for preventing disease transmission is much greater than that of any individual physician.

Our universities have made available an ample number of adequately trained men and there is no reason why a person in responsible charge of water purification processes should not be thoroughly versed in the science and technique of his duties. Fortunately, there is now a movement away from the practice of giving laborers a few weeks instruction as a means of qualifying them as operators and toward insistence upon basic scientific training in conformity with high academic standards.

Marked changes in ionic concentration of substances in water is suspected of responsibility for some of the milder forms of intestinal disturbances. This may account for some of the physiological effects attributed to flood waters. Some 22,000 cases that may fall in this class occurred in Milwaukee recently according to report of the Wisconsin State Board of Health.

The last few years have revealed wide distribution of fluorine in water supplies from underground sources. Its known injury to teeth and bones, especially among children, have greatly increased the alertness of waterworks officials and particularly of engineering departments of state boards of health to its occurrence. Only last year in Ohio, Scott and co-workers developed a method for removing fluorine from water in connection with the process of water softening.

Corrosion of piping is not merely a nuisance in hot water systems and expensive in the maintenance of piping within buildings, but it also seriously affects the carrying capacity of the distribution system. Much

Fig. 2. Laboratories properly staffed and adequately equipped are playing their part in maintaining high quality standards in water purification. This laboratory, at Hammond, Ind., was designed by Greeley & Hansen, engineers.

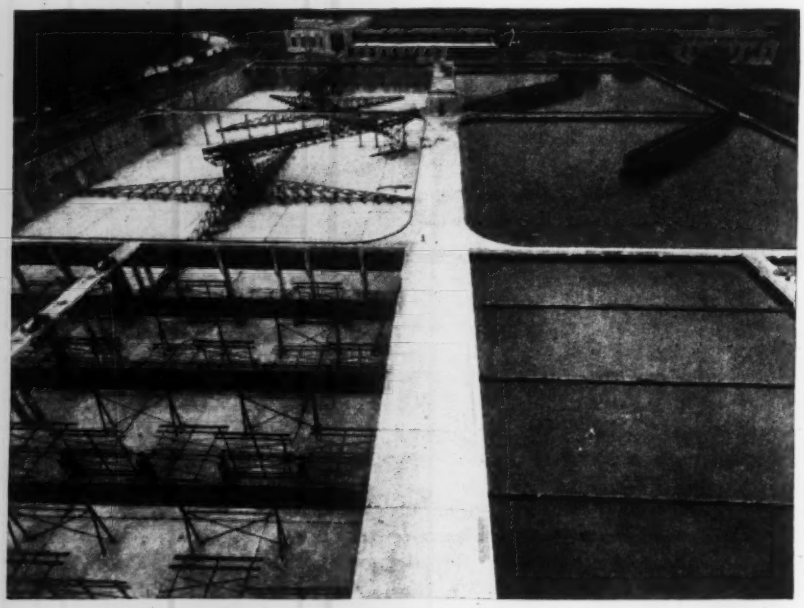


Fig. 3. New installations for water purification continued active during the year, and there are now in service 2,120 municipal filtration plants. Parts of Cincinnati's new facilities, above, Burns & McDonnell engineers.

active discussion has taken place of means for determining a corrosion index by laboratory methods and by computation based on usual laboratory determinations of the mineral content of water. Tuberculation, which has generally been looked upon as a form of corrosion, is often primarily due to the activities of organisms. Effective sterilization of the water may prevent tuberculation and preserve the carrying capacity of pipe lines even when carrying water with a somewhat unfavorable corrosion index. Active sterilization also prevents the formation of slimes on condenser tubes, which interferes with heat exchange and increases frictional losses. The new industrial water supply for Birmingham, for instance, contemplates the use of heavy chlorination to prevent tuberculation and the formation of slimes. The same results may be obtained in a domestic water supply by the use of chloramines.

An aspect worth noting in the purification of waters taken from the Great Lakes is that filtration renders it unnecessary to build long intakes into clear water areas, because the more or less turbid water near shore is easier to coagulate and filter than is clear water. The only present necessity for long intakes is to reach beyond the influence of gross shore pollution, which should not be permitted in any event, or to reach a depth of water, about 25 ft., that will avoid ice formation that may clog intake ports.

Revival of chemical coagulation in sewage treatment has given new emphasis to effective flocculation and sedimentation in water. The objective is to approach complete displacement as nearly as possible. In sedimentation streaming currents must be avoided as these result in short circuiting and disturbance of the settled and settling solids. Experiments with circular sedimentation tanks at Wayne University, Detroit, are noteworthy and form the basis for an improved inflow design for sedimentation tanks.

In the field of water softening Charles H. Spaulding at Springfield, Ill., has established the principle of effective precipitation of carbonates by upward flow of treated water through a sludge cloud. The same principle has been tried experimentally at Minneapolis and a full plant scale with an installed 120-m.g.d. capacity is under construction.

The possibilities of remote control and robot operation are attracting attention. Much has been done in the automatic control of pumping stations by water-level or pressure changes. Automatic control of chlorine feed has also been solved. Filters of the pressure type and zeolite softeners have been devised for automatic operation. They are actuated by water pressure and time control. The filters wash and the softeners regenerate without attention other than to replenish the chemicals used.

Gravity filters have been made partly automatic, that is, they are started and stopped by water-level fluctuations, but none has been devised for self-washing. Complete automatic control of gravity filters, however, is entirely possible. The washing mechanism could be started by the loss-of-head gages, the sequence of opening and closing valves could be controlled by timing devices and a photoelectric device might terminate the washing period when the soiled wash water is sufficiently clear. The use of hydraulically and electrically operated valves and a variety of mechanical equipment for a number of years has reduced the labor for operating sizeable water purification plants to an almost negligible factor, therefore full automatic operation does not offer a prospect of much further economy.

In 1927 clear principles of filter bed cleansing were brought out by experimental work in Detroit. This matter still holds the attention of water purification men and the past year has seen a wide acceptance of the surface wash. The new Milwaukee filter plant will employ this type of wash.

Within the past few years there have been placed on the market a number of preparations, washing fluids, and powders that are completely effective in softening hard waters without producing precipitates or curds. The question arises as to whether these products will make municipal water softening unnecessary. The answer is that they will not; first, because they do not solve the problems of boiler and pipe incrustation and cooking, and second, because they are expensive as compared with large scale softening at the city waterworks. Commercial laundries find lime-and-soda or zeolite softening more economical than the use of any of these newer compounds, but sometimes small quantities of the compounds are used even with softened water to counteract the sulphates and carbonates or calcium and magnesium carried in the soiled fabrics and also for their detergent qualities.

Efficient Distribution Service

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New means for studying hydraulic flow and pressure conditions provide the basis for more accurate design and layout of pipe systems

Effective distribution of water in a municipality or a metropolitan area depends primarily upon the proper design of the system facilities and secondly upon the proper operation of these facilities. Recent progress in waterworks engineering has placed in the hands of the designer new devices and methods which undoubtedly in the future will be largely used for a more rational approach to the problem of getting water to the consumer.

Ordinarily 50 to 70 per cent of the total cost of a waterworks property is represented by the distribution system. In spite of this fact the distribution system probably receives less study from the viewpoint of accurate design than any other part of the entire property. Reinforcing mains, laterals and storage are often constructed without a definite knowledge of how they will function. Examples may readily be found of equalizing storage facilities improperly placed with respect to the center of demand, storage with such inadequate connecting mains that it fails to function when needed, and installation of new mains capable of relieving only existing conditions rather than providing for future service as well.

That these faults exist is largely due to an imperfect understanding of just what happens in the distribution system during periods of critical demand. It is safe to say that to date no observations have ever been made that completely or even partly reflect the operating conditions throughout the system on the day of maximum demand. True, most systems are supplied with pressure gauges but these often are poorly located with reference to the trunk mains and reveal nothing as to the conditions of flow where they are located or in the trunk mains.

Measuring devices important

Modern instruments are available which can readily be adapted to the purpose of measuring flow throughout a system, the record of which can be made at the point of measurement or transmitted to a place of central observation. Such instruments installed at critical points on the trunk mains would provide a simultaneous record of flow throughout the system and, when coordinated with the metered values of input to the system, would provide an invaluable means of determining usage, leakage and deterioration of pipe lines. It is to be hoped that designers will install such apparatus, looking forward to the day when critical conditions of flow in the trunk main network may be definitely determined and studied. Certainly the investment in trunk mains warrants the small additional cost of such measuring devices.

Hypothetical problems involving future conditions of service can be based only in a general way on conditions existing at present. Co-efficients of friction in existing or proposed pipelines will change, population will shift and the character of individual usage will vary.

The value of C in the Hazen and Williams formula decreases with the age of metal pipe. The rapidity with which this value decreases and the frictional resistance increases depends largely on the character of water. The so-called active waters cause tuberculation and rapid increase in frictional resistance. Poorly treated water will also cause tuberculation and very often produce incrustation, depending on how the water is "mistreated" in the purification process. Accordingly, local conditions will determine to a large degree the value of C in the hypothetical conditions which the designer sets up. Often where successive observations have been made of the value of C, future predictions based on such observations, may be made with a relatively high degree of accuracy. Lacking such determinations the designer must fall back

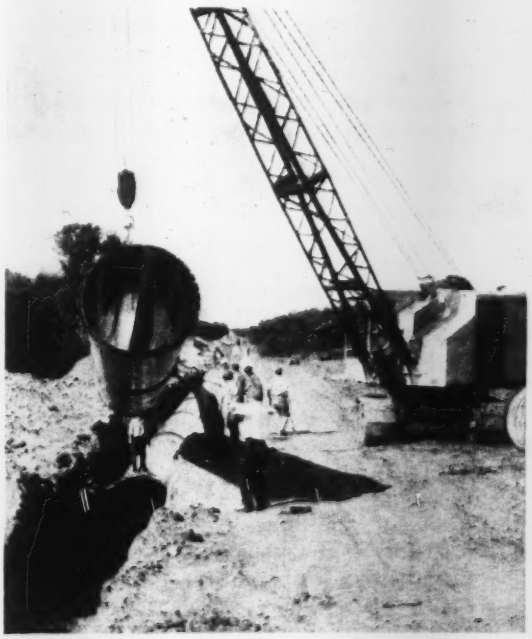

Fig. 1. More than half the cost of a water system is buried underground in the form of distribution facilities.

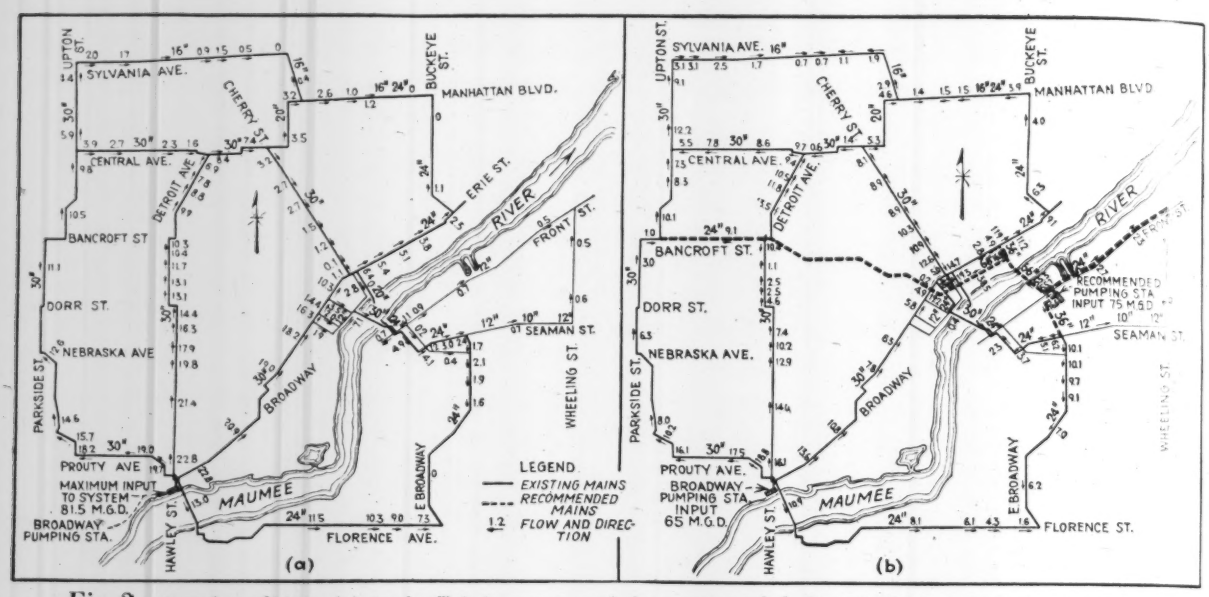

Fig. 2. Actual conditions (a) in the Toledo system, and the recommended changes (b) to meet 1950 demands.

on the general studies and observations made and published in waterworks literature. The recent report of the committee on pipeline coefficients of the New England Water Works Association is an excellent example of such information.

Machinery for studying the variation or shift in population in American cities heretofore has not been well set up. The U. S. Bureau of Census has reported population by wards, but only in a few cases have the wards represented the same identical areas in successive census-taking periods. With the establishment of "Census Tracts" in 1930 this situation largely has been corrected. These tracts once established will not be changed. The character and change in population and industry within the tract will be recorded and thus made available to the engineer and statistician for study.

Waterworks engineers are quite familiar with the ordinary assumptions that the use of water in American cities approximate 100 gal. per capita, that usage on the maximum day will be 150 per cent of the average and that the maximum hour rate will be 150 per cent of the maximum day or 225 per cent of the average day rate. There is virtually no definite knowledge of the per capita rate of usage throughout the city or how the maxima may vary in the different sections of the area served.

In a recent survey of the Eastern Hills district at Cincinnati, some 52,000 consumers' accounts extending over several years were examined and classified by meter districts and census tracts in an attempt to determine average usage and the variations from the average.

It was found that the meter districts could be divided into three types as follows: (A) those showing variations in usage closely approximating the variations for the entire district (B) those showing smaller variations and (C) those showing greater differences than the average for the district. Tabulated and expressed as gallons per day per capita, the following results were found most nearly to approximate the conditions:

	Average	*Max. Day*	*Max. Hour*
Entire District	105	174	333
Type A Districts.....	105	174	333
Type B Districts	150	174	226
Type C Districts.....	79	175	396

About 47 per cent of the population served was in type A districts, while 20 per cent was included in type B districts, and 33 per cent in type C districts. Almost without exception type C districts were in the outlying areas of the city or in the county with little or no industrial or commercial usage. Type B districts were in the older parts of the city and included industrial and commercial areas. Type A areas were located geographically between the other two.

The ultimate object of a study of population and use is to determine the amount and location of draft on the trunk main system. With this information available for critical periods of demand, such as the maximum hour, it is possible to set up a hydraulic analysis and determine the actual flow and pressure throughout the system for present demands or for future hypothetical conditions.

No system for analyzing the flow of water in a network of pipe such as the trunk mains of waterworks has ever been devised that is quite as satisfactory as the Hardy Cross method. It is simple, direct and readily understood. The original article describing it appeared in *Engineering News Record*, Oct. 1, 1936, p. 475 and a simplification in the issue of Mar. 3, 1937, p. 342. Methods heretofore available have been complicated and tedious and on this account were practically never used. Practical experience in the use of the Cross method has convinced the authors that it represents the greatest advance yet made in this branch of waterworks engineering. Application of the method is illustrated in the following examples.

In Fig. 2a conditions of flow in the trunk main system at Toledo at the maximum hour July 13, 1936, are represented. Low pressures in the outlying areas were a general source of complaint. In the downtown district at Erie and Cherry Sts. pressure dropped to 28 lb. per sq. in.

and at Florence Ave. and East Broadway in the center of a heavy industrial area, a low value of 11 lb. was indicated. Throughout the city only a few consumers were receiving the amount of water desired. In Fig. 2b is shown the conditions for the hypothetical maximum hour of 1950. The improvements indicated represent the final recommendation after successive analyses of various plans proposed. All poor pressure conditions have been corrected at flows adequate to meet the expected water demands.

In Fig. 3a the flow in the trunk main system of the Eastern Hills district at Cincinnati under conditions assumed to exist during the maximum hour period of 1950 are illustrated. The proposed trunk main, together with the new pumping station near the filter plant, was designed to correct the low pressure conditions in the district and at the same time permit the Winton Road reservoir to function properly as equalizing storage.

Poor service in the high areas near the Kennedy Heights tanks and in the vicinity of McMillan and Clifton Sts. was not improved by the proposed arrangement. In fact the analysis shows very low or negative pressures for these locations. The analysis further indicates the necessity of lowering the pressures on the pumping stations during the day to permit proper operation of the Winton Road reservoir. A second analysis of flow conditions during the night hours when the reservoirs were being replenished indicated that the pressures on both stations increased to high values. In the case of the main station this pressure was beyond the limiting pumping head.

The solution at Cincinnati as finally developed after a study of five possible plans is indicated in Fig. 3b. The recommended plan eliminated all the deficiencies revealed in the existing system and in the other plans studied.

A new high service pumping station at the filter plant serves an intermediate district at a pumping head 45 lb. less than that at the main station. Water is delivered direct to the Mount Washington district. Pleasant Ridge is served by a booster station supplied from the intermediate district. Pumps at the main station now serving the existing Eastern Hills district are allocated to a limited area of high ground which comprises the district as originally established. The load on the main station and the gravity tunnel serving this station is reduced and the capacity life of these units thus extended. The plan provides for more direct delivery of all water pumped and assigns the new rapidly growing areas of the city to new pumping stations.

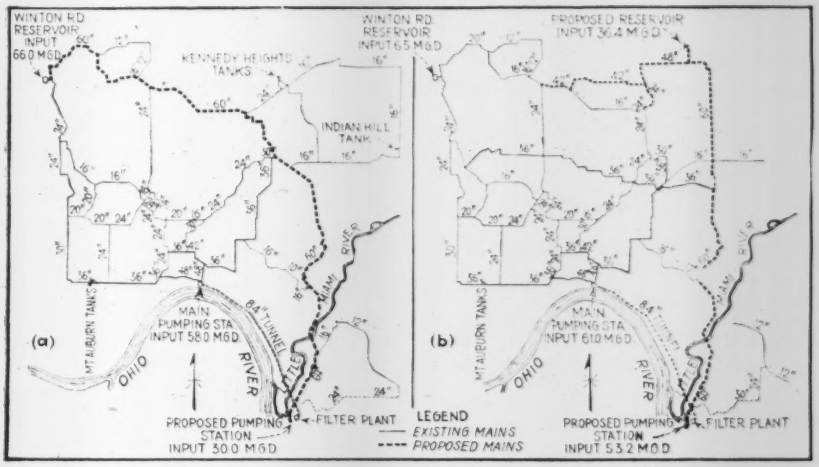

Fig. 3. Proposed betterments (a) at Cincinnati which later analysis indicated would not improve conditions, and (b) the final solution.

Perhaps other methods of analysis could have been used successfully in the solution of the problems at Toledo and Cincinnati but it is certain that no method would have provided such complete and conclusive evidence of the merits and faults respectively of the plans illustrated. The rational approach to all such problems in the future undoubtedly will be based on new and improved methods of studying conditions of flow in the trunk main system. Proper studies of population trends and movement will be the basis of estimated future service conditions and the Hardy Cross method will provide conclusive solutions to the hypothetical conditions.

Elevated Storage Aids Water Distribution

To provide better water service in the high southwest section of the city, Holland, Mich., recently installed a 500,000 gal. elevated storage tank. This installation has eliminated distribution difficulties due to the limited capacity of wells which formerly served this area.

The tank is connected with the distribution system so that it can be supplied both from the adjacent well field and a pumping station located in another section of the city. The pumping schedule is so arranged that the tank is filled during off peak hours. Aside from supplying ample quantities of water for domestic and industrial use, it is now possible to maintain adequate pressure at all times for fire-fighting purposes.

The work was carried out under the direction of Abe Nauta, superintendent, and Charles Vos, assistant superintendent, of the Holland board of public works. Hamilton & Weeber, Grand Rapids, served as consulting engineers, and the Chicago Bridge & Iron Co. erected the tank.

Meeting Peak Demands

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Methods used in determining the design of a distribution system to supply a maximum demand of 400 gallons per day per capita

PLANNING a distribution system to handle a maximum demand of 400 gallons per day per capita was the special requirement in expanding water supply facilities at Highland Park, Tex. This called for a design having large reserve pumping capacity, ample elevated storage, and adequate distribution mains properly interconnected. The various steps in analyzing the situation are here outlined as an example of method in making a study of distribution needs and the manner in which special conditions were satisfied.

Highland Park, with a population of 10,000, is surrounded on three sides by the city of Dallas and on the fourth it is bounded by the city of University Park. This limitation on boundaries makes it possible to obtain a close forecast of ultimate population. The town is the outgrowth of a high-class residential development in which industrial activity is prohibited and commercial activity is restricted to a small area.

A large part of the community is given to park purposes, and special care is devoted to the landscaping of parkway areas between curbs and property lines. Purchasers of property agree to an annual assessment of one cent for each 10 square feet of land in order to maintain these areas, and the efficient care given to the park areas acts as an incentive for property owners to maintain their premises in keeping with the surroundings. All of these activities lead to a large water demand.

A comparison of water consumption with towns having similar soil conditions, population and rainfall, covering the 6 yr. period from 1931 to 1936, illustrates the heavy demand:

Greenville	44 g.p.d. per capita
Waxahachie	47 g.p.d. per capita
Corsicana	58 g.p.d. per capita
University Park....	88 g.p.d. per capita
Highland Park	116 g.p.d. per capita

Gathering basic data

The first step in making the analysis was to assemble records showing consumption. The chart shown in Fig. 2 was then made up to show average daily water consumption per month expressed in gallons per capita per day, and to also indicate departures from normal precipitation by months during the period 1931-1936. It will be noted that the average consumption ranges from 75 to 325 g.p.d. per capita. In Fig. 3 is shown the percentage of time covered by the various rates of consumption. This curve has been constructed for the 84 months in rising sequence of consumption regardless of reference to dates.

Since the rapid development of the town and heavy use of water on new properties might possibly raise the average per capita consumption, an investigation was made to determine the trend of consumption. Records of water users who were long-time residents in the older part of the town were reviewed to see if a long period of residence would show a tendency toward lessened water consumption. These records were divided into three groups—1-story houses on small lots, 2-story houses on medium-sized lots, and large houses on large lots. No indication was found of a general reduction in

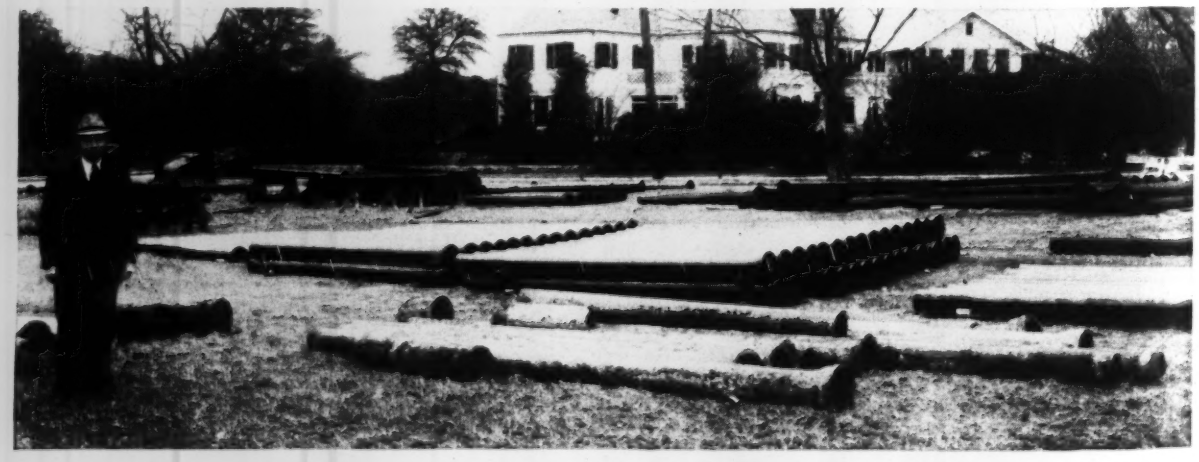


Fig. 1. Pipe cleaning yard where old pipe was reconditioned by scraping and brushing both the interior and exterior and then painting the outside.

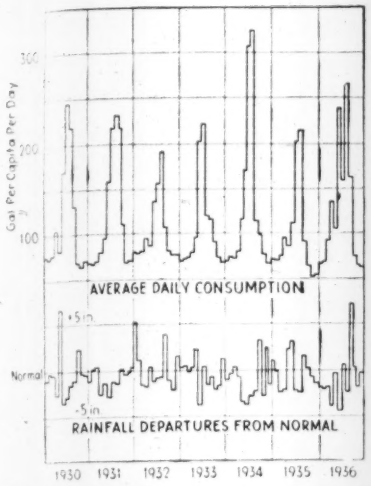


Fig. 2. Monthly water consumption and rainfall data.

use. The large water use for lawn irrigation was reflected in the peak demands of June, July and August, at which time the per capita consumption exceeded 250 g.p.d.; this figure was higher during the years of deficient rainfall. In 1934, for instance, when the town had a population of 9,150, with an average per capita consumption of 137 g.p.d., a maximum demand of 418 g.p.d. occurred on Aug. 22. The average for the three summer months was 290 g.p.d. while the August average was 325 g.p.d. A definite relation is exhibited between the use of water and the rainfall, and it was noted that cloudy days affected water consumption materially.

System requirements

Demands such as the above call for a system having ample reserve pumping capacity, ample overhead storage, and adequate distribution mains and inter-connections. In addition to the above requirements to meet domestic needs, it is necessary that the system be able to supply sufficient water for fire protection purposes.

The possibilty of additional demands on the system for air conditioning use was also reviewed. In this connection experience of other towns and the records of several local installations were studied. The local records probably show the trend of future installations of air conditioning and the water requirements. None of these included condensers or cooling towers when first installed but after one season, cooling towers were installed in every place due to the prohibitive cost of water. As a result of this study, it was concluded that the town could not afford a water system adequate to meet the combined demands of lawn irrigation and air conditioning, and it was recommended therefore that the town consider the passage of an ordinance requiring condensers or cooling towers on air conditioning installations.

A study of Fig. 3 led to the conclusion that a consumption of 250 g.p.d. per capita should be adopted as a basis of design under normal demand. This gives for the present population of 10,000 an equivalent of 2,500,000 gal. per day and for the ultimate population an equivalent of 5,000,000 gal. per day, or 1,750 g.p.m. and 3,500 g.p.m., respectively. Peak days have already produced demands of 2,700 g.p.m., or a peak rate in excess of 4,000 g.p.m.

The location of the pumping plants and elevated storage were next determined, along with their approximate spheres of direct influences on the system. The ultimate water consumption by blocks was computed and totaled by areas which were to be served by the mains operating between the pumps and the overhead storage.

Pipes and pumps

In the determination of the size of mains, the following factors were taken into consideration: (1) the annual cost of owning a given size of main, and (2) the annual cost of pumping the desired quantity of water through that size of main.

The annual cost of ownership includes cost of pipe in place plus material amortized at the prevailing rate of interest over the life of the pipe, which was assumed in this case as 100 years.

The pumping costs are determined by taking into account the various rates of pumping through the line and the length of time the pumps operated at these rates. This time rate was determined from Fig. 3.

Curves showing the combined cost of owning and pumping through various sizes of lines were plotted for the various sizes of pipe. These curves (Fig. 4) show the economical limits for the various sizes under conditions applicable to this particular problem. The point of intersection of these curves indicates the economical point at which an increase should be made in the size of pipe, and it is on the basis of these calculations that the improvements in the distribution system were determined.

There are at present two pumping plants; one located in the northeast section of the town with a capacity of 750 g.p.m., and the other in the south central portion of the town with a capacity of 3,000 g.p.m. The smaller plant will be increased to 1,250 g.p.m., but no change will be made in the larger station. A new plant is to be located in the northwest portion of the town with a capacity of 1,250 g.p.m. making the total available pumping capacity equal to 5,500 g.p.m., with the plants well located for preserving uniform pressures. Water is obtained from two feeder mains of the Dallas supply system which pass through the town.

The relation between pumping rates and storage for a daily consumption ranging from 1.5 to 7 m.g.d. is shown in the accompanying table. The relation between the average rate of pumping, total con-

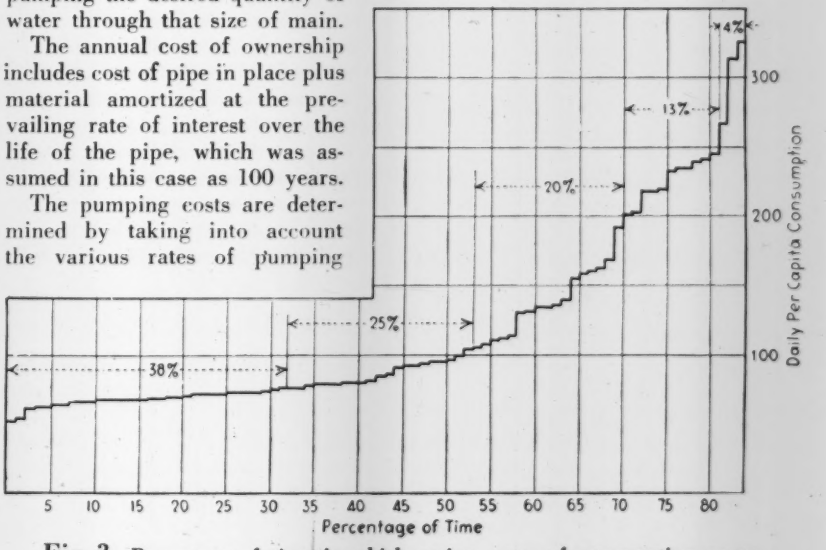


Fig. 3. Percentage of time in which various rates of consumption occur.

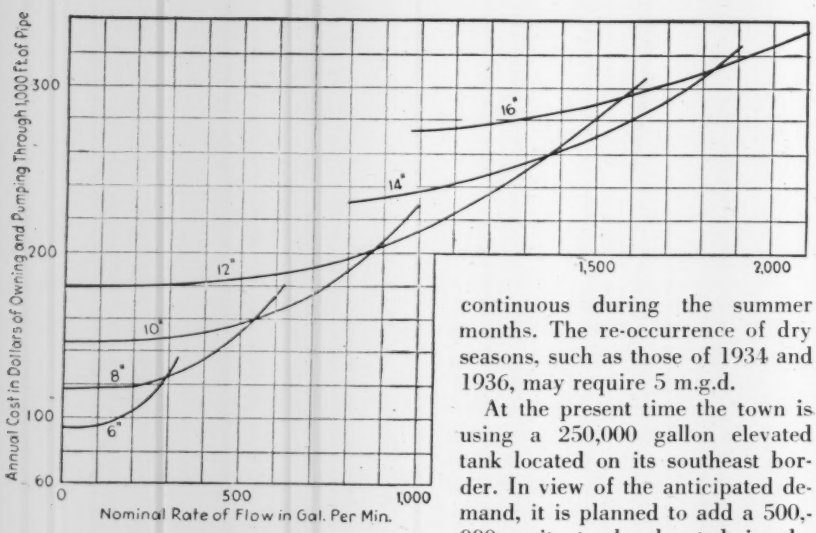


Fig. 4. Economical sizes of mains for various rates of flow.

in the column marked "24 hour period." For example, a day in which 3.5 million gallons are used would require a storage capacity of 588,000 gallons in order that a uniform pumping rate of 3.5 m.g.d. can be maintained over the 24 hr. period and meet all demands for water. Should there be but 500,000 gallons storage available, this same column shows that for 13.5 hr. of the day a pumping rate of 3.672 m.g.d. would be required, and for the remaining 10.5 hr. a pumping rate of 3.270 m.g.d. could be maintained. The study on which the table is based was made with the view to determining storage requirements necessary to reduce peak pumping rates and thereby hold the monthly and annual power demands to a minimum and obtain efficient pump operation.

Pumping records show that the 3.5 m.g.d. rate will occur with increasing frequency until about 1940, when this demand will be practically continuous during the summer months. The re-occurrence of dry seasons, such as those of 1934 and 1936, may require 5 m.g.d.

At the present time the town is using a 250,000 gallon elevated tank located on its southeast border. In view of the anticipated demand, it is planned to add a 500,000 unit, to be located in the southwest part of the town. The elevated tanks will be equipped with water stage meters, recording the elevation and pressure at the largest pumping plant. The pumps at the other two plants will be equipped with automatic start and stop devices operated by dial phones from the main station. This control will enable any pump to be started or stopped and a switchboard will indicate what units are operating or idle. Pressure gauges will act as a check on the performance of the pumps, while venturi meters will record on combination charts the amount of water pumped, rate of flow and suction and discharge pressures.

In addition to the pumps and overhead storage indicated above, the additions to the distribution system will include about 7,600 ft. of 6 in., 11,700 ft. of 8 in., 10,500 ft. of 10 in., 6,700 ft. of 12 in., and 2,200 ft. of 14 in. cast iron pipe. The total cost is estimated at $235,000. It is planned to salvage about 10,400 ft. of cast iron pipe ranging from 4 to 8 in. in diameter and rehabilitate it for further use. The pipe, after removal from the ground, is hauled to a central storage yard where it is thoroughly cleaned and given a hot tar application. Part of this pipe has been in use since 1911. It shows practically no sign of corrosion.

The Highland Park water supply extension is under the supervision of Roderic B. Thomas, town engineer, and Myers, Noyes & Forrest, consulting engineers.

RATES OF PUMPAGE AS AFFECTED BY STORAGE FOR VARIOUS DAILY CONSUMPTION DEMANDS

Hours Pumped	AVERAGE RATE MILLIONS OF GALLONS PER DAY											
	1.5		2.0		3.5		5.0		6.0		7.0	
	Rate	Storage	Rate	Storage	Rate	Storage	Rate	Storage	Rate	Storage	Rate	Storage
13.5 Hr. Period									7.52	250,000	8.847	250,000
							6.178	250,000	6.992	500,000	8.333	500,000
					4.163	250,000	5.680	500,000	6.506	750,000	7.830	750,000
			2.172	250,000	3.672	500,000	5.183	750,000	6.02	1,000,000	7.346	1,000,000
24 Hr. Period	1.5	252,000	2.0	335,000	3.5	588,000	5.0	840,000	6.0	1,008,000	7.0	1,176,000
10.5 Hr. Period			1.768	250,000	3.270	500,000	4.770	750,000	5.980	1,000,000	6.556	1,000,000
					2.567	250,000	4.093	500,000	5.333	750,000	5.873	750,000
							3.472	250,000	4.624	500,000	5.138	500,000
									3.838	250,000	4.316	250,000

• • •

Cork Insulation Prevents Water Pipe from Freezing

To PROTECT an exposed water main from freezing during the extremely low temperatures of Canadian winters, the city of Ottawa has insulated a recently installed conduit with a cork cover. The pipe, 48 in. in diameter and carried over a river channel on a steel bridge, is used to convey water from the treatment plant located on an island to the distribution system on the mainland.

As described in *The Power Specialist*, the insulation was applied after 1¼ in. steam lines were placed on either side of the pipe. These steam lines were covered with half-sections of asbestos insulation so placed as to leave the portion of the steam pipe line next to the water main uncovered. With the insulation for the steam line thus placed, the entire assembly was next wrapped in a layer of expanded metal of sufficient strength and rigidity to maintain an air space between the water main and a rock cork covering which was applied later.

Two layers of rock cork were applied in such manner that none of the joints of the outer layer coincided with those of the inner layer, either horizontally or transversely. To complete the job, a weatherproof coating was applied over the rock cork. The insulation is said to be sufficient to prevent still water in the pipe from freezing during a six-hour period under minimum weather conditions at an atmospheric temperature of 30 degrees below zero.

The purpose of the steam line is to heat the air space surrounding the water main in case the need should ever arise. Normally there will be no steam in these lines, and the guarantees made by the insulation contractor are entirely independent of their use.

Cross-Connection Crimes

JOEL I. CONNOLLY
Assistant to the president, Chicago Board of Health

Preservation of the purity of water in the distribution system involves elimination of hazards back of the property line

WANTON DESTRUCTION of human life is a crime and the waterworks man who prevents loss of life is a crime-buster. Often the search of the cross-connection or other health hazard in a water supply is just as baffling as the mysteries surrounding the plot in a best-seller. Just as the war against crime is carried out on a constantly shifting front, the focus of the age-long struggle against water-borne disease changes from time to time. Formerly it centered largely on the source of water supply; now the scene of active battle is shifting to the "distribution front."

The detective wishing to solve water-borne disease mysteries today finds his most fertile field in the maze of pipes and fixtures that form part of the distribution system. The great development in air conditioning of recent years entails the new duty of meeting and overcoming its dangers. Air conditioning has so much in its favor that it may surprise many people to hear of its dangers, but they are by no means imaginary. The water-borne outbreak of amebic dysentery in Chicago during the World's Fair was caused, in part, by pollution of water taking place through a sewer cross-connection from the condenser of an ice machine used for air conditioning. Similar dangerous conditions have been noted elsewhere. No fewer than 589 direct ice-machine condenser cross-connections to sewers have been found and removed in Chicago alone in the past four years, many of them in counter freezers in ice-cream stores and soda fountains.

Air conditioning hazards

There are three general types of hazards from cross-connections or interconnections, of varying degrees of danger, commonly encountered in connections to air-conditioning apparatus: (1) direct sewer connections; (2) back pressure from circulating pumps; and (3) make-up water inlets submerged in air-washer pans.

Considerable quantities of water are used for condensing in the ice machine which form a part of air-cooling systems. Frequently, the amount of condenser water exceeds the domestic consumption in the building. It must be wasted to a sewer, stored for future use or put through a cooling tower. Storage is ordinarily impossible and cooling towers have certain disadvantages, so there is a strong tendency to connect the condenser discharge both to the domestic water supply and to the sewer. This arrangement existed in the hotel where the Chicago amebic dysentery epidemic originated.

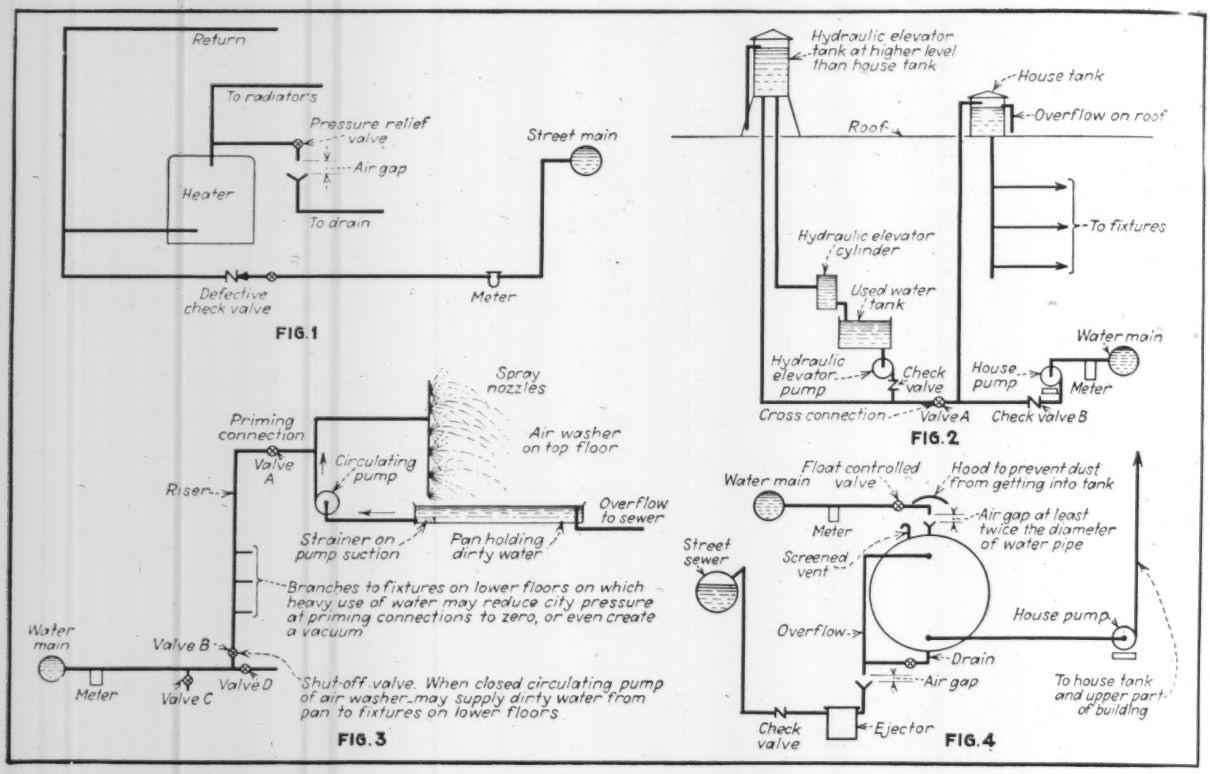
Whenever the pressure of water in a building is increased above that existing in the street mains and pollution of the water in the building may occur, a hazard to the safety of the water in other buildings is created. The water pressure may be increased by means of a booster pump, (frequently termed a house pump), but may also be due to other causes. For example, a connection to a heating plant was the cause of contaminating the water in the street mains and neighboring buildings with material put in the heater to seal leaks. The piping layout is shown in Fig. 1. The trouble was discovered through discoloration of the water in a nearby structure and traced through the main and a faulty check valve to the heater. The pressure relief valve was set higher than the city pressure and the check valve leaked. Another unusual case of developing a higher pressure than that in the city mains was discovered in a garage where the compressed air hose was attached to a water pipe in order to run the meter backward and cut water bills.

Still another illustration is a leak through the material separating the ammonia and the cooling water in an ice-machine condenser. The ammonia was forced through the leak into the water and thence into the street main. Also, a situation shown in Fig. 2, found in a large hotel, permits previously used water from a hydraulic elevator system, heavily contaminated as shown by laboratory tests, to enter the house tank and entire domestic water system, if valve "A" leaks. Polluted water may also find its way back into the street mains, as well as into the house tank of the hotel, if valve "A" leaks when the house pump is not in operation and when check valve "B" is also leaking.

Probably one of the worst examples frequently found is the priming connection to a sewage pump, where sewage can be pumped directly into the water mains. A small outbreak of diarrhea among employes of a power plant has been traced to such a priming connection. A rarer case is the connection of a water pipe to the discharge of a sewage ejector. Such a connection is reported by the U. S. Public Health Service in a recent bulletin. In this case the water jacket of an air compressor was directly connected to the ejector discharge pipe 20 ft. below the street sewer. A condition somewhat similar to this, though less hazardous, was found in a Chicago hotel in 1934.

In addition to the formation of higher pressures in the building, there is another aspect of this problem, namely, the creation of a lower pressure or even formation of a vacuum in the street mains. This may occur as a result of heavy pumping by fire engines, by shutting off and draining portions of the distribution system or through breaks in pipes.

Even though the additional pressure provided by a booster pump is not great, a health hazard may be cre-



Cross-connection arrangements showing: (1) piping which permitted leak-sealing compound in boiler to be forced back into the street main; (2) a bad arrangement which permits used water to enter the house tank should valve A leak, and permits used water to enter the city main should valves A and B leak; (3) priming connection which permits the circulation pump to discharge into the house system if valve should leak or be left open; and (4) suggested surge tank arrangement where house pressure exceeds that in water main.

ated. For example, an air-washer circulating pump on an upper floor of a building may not develop much pressure compared to a fire pump. Still, when the city pressure at that elevation is near or below atmospheric pressure, a priming connection, such as shown in Fig. 3, may lead to gross contamination of the domestic water supply, should valve "A" on the priming connection leak or be left open after the pump starts. Recording gage charts made on upper floors of buildings in Chicago, Minneapolis and Pasadena, agree in showing that drops in water pressure to atmospheric pressure and creation of a negative head are by no means uncommon. By referring to Fig. 3 it may be seen that closing valve "B" at the foot of the riser may permit the air-washer pump to supply fixtures in the building regardless of the adequacy of the city water pressure. Also, if the service connection to the main is small or if its capacity is diminished by deposits or tuberculation, the wide opening of valve "C" or valve "D" may cause the entrance of dirty water from the air washer into the domestic water supply system.

Dangerous conditions which menace the safety of water supplies should not be permitted to exist in any building. Theoretically, the authority carrying the health responsibility for the city should prevent their creation. Practically, it may be questioned whether this is being done completely in any city. Even a few days or hours after an inspection has been completed, a dangerous situation may be created without the slightest notice. For example, a large office building in which 25,000 people are regularly employed was thoroughly inspected at the time of its erection, and the plumbing was found to be satisfactory. Shortly afterward complaints to the Board of Health of diarrhea among employes of one of the tenants caused an investigation to be made of the water system, during the course of which a recently installed cyanide tank with a submerged inlet was discovered in a silver plating establishment in the building. This tank, containing a strong solution of one of the most violent poisons known, was so connected that siphonage of its deadly contents into the water supply was easily possible. The connection was immediately dismounted but the fact that a situation so hazardous could develop, unknown and unhindered, demonstrates the futility of attempts to keep all possible sources of contamination out of buildings by inspections alone.

What then can be done about it? Much can be done, principally through education of engineers, architects, plumbers and property owners, supplemented by inspections, plan examinations and identification of pipes by distinctive colors. Where the house water pressure is raised above the city pressure, by booster pumps or otherwise, and water contamination may occur in the premises, (and particularly where an auxiliary unsafe source of water supply exists) this education may not suffice to give protection. Then, in addition to such measures, it may become advisable to limit to the building any pollution of water that may occur, and prevent its travel back into the city mains and thence

to other premises. Such contamination of the water in the street mains by backflows may be prevented by making a physical separation of the house system from the mains by the use of a surge tank. (Fig. 4.)

Conditions are often encountered in high buildings where the lower floors of a building are supplied with water under city pressure, and the upper floors are supplied through a booster or house pump. Where a surge tank is used to make a physical break between the city main and the house pump, care must be exercised to discover and eliminate interconnections which may permit the water discharged by the house pump to find its way back again to the mains, possibly through another separate service connection.

Any fixture so arranged that the water enters below the surface of its contents, may be the means of contaminating the water in the pipes by siphonage or back pressure. This hydraulic principle applies to the flush valves or tanks used on toilets, tubs and other fixtures.

Ten years ago it was common practice to have instrument and utensil sterilizers in hospitals supplied with water through an inlet in the bottom of the fixture. Although the manufacturers of hospital sterilizers have discontinued making sterilizers with submerged inlets since their attention was called to this hazard in the spring of 1928, it is regrettable to note that some air conditioning installations where plumbing inspection is lax, have been made with submerged inlets. Such an arrangement invites siphonage of the dirty water from the pan into the water supply of the building, and in some cases, even into the street mains. It is customary to have in the pan a standing waste and overflow, constantly open to the sewer, for the purpose of keeping the water level from rising above a predetermined level. There is nothing to prevent the backing up of sewage into the air-washer pan, however, whenever the sewer becomes obstructed or flooded.

Pressure in water mains may vary greatly and sometimes drop suddenly due to unforeseen emergencies thus drawing into the main contaminated water. In a hilly city obviously great differences in pressure exist between hill top and valley. Should a main burst in such a city, the pipe may drain rapidly and cause the formation of a high vacuum. Likewise a conflagration may bring so many fire engines to the scene that the pressure in the mains is greatly reduced or a vacuum created.

One morning last summer a fire broke out in a factory district in Chicago. Because of repair work in progress on water mains in the vicinity, the quantity of water was limited. Before long a vacuum was produced in the mains by the suction of the fire engines. Near at hand was the heavily polluted south branch of the Chicago River. The fire grew worse and in desperation a fire boat was sent. A hose under considerable pressure from the fire boat was connected to a siamese connection on one of the fire engines which had been unable to get sufficient water from the hydrant. The other half of the siamese was still attached to the hydrant from which it had been pumping. Presently it occurred to some one that river water, because of its much higher pressure, was going into the city mains through this siamese, and the hydrant was thereupon quickly closed. The resultant water hammer burst the hose leading from the hydrant to the fire engine, showing that there was a flow from river to the mains. The Board of Health and Water Department were notified immediately by the Fire Department, and took the necessary precautions to avoid an outbreak of water-borne illness. Where a building has a standpipe with connections to which a fire boat may attach a hose, a similar hazard may exist.

The safety of the drinking water will never be assured until every link in the chain of protection is made strong. Huge sums have been spent to secure safe sources of supply. It is now time to pay a commensurate amount of attention to the equally important and often more difficult task of keeping the water safe after it enters the distribution system.

Water Quality on Trains Impaired by Careless Handling

BACTERIOLOGICAL tests made on 1,090 samples of drinking water collected from cars operated by nine different railroads with terminals in the New York City area indicated that at least two of these railroads were inefficiently cleaning their storage containers or contaminating the water by handling it in a careless and insanitary fashion, according to investigators of the U. S. Public Health Service. The findings were reported by A. P. Miller and E. C. Garthe, sanitary engineer and junior sanitary engineer, respectively, of Interstate Sanitary District No. 1.

The purpose of the work, as described in the *Public Health Reports*, Vol. 53, No. 8, was to determine whether the sanitary measures in vogue and the protective devices employed in the terminals were effective in protecting the quality of water during its passage from the mains of the municipality supplying it to the consumers on the trains. It was assumed that if a carrier did not adequately protect its car watering facilities against contamination, this would be reflected in the quality of the water secured from the coolers and other containers.

Samples were taken from all types of cars without any attempt to be selective. Since the samples did not originate from a single source of supply, the Treasury Department standard for drinking water could not be applied to the laboratory results. It was possible, therefore, only to evaluate the results secured on each railroad's series of samples by comparing them with those that would be obtained from samples of water free from contamination and with the results of the tests on each other railroad's series. Samples showing three or more 10 c.c. tubes positive for the *coli-aerogenes* group were considered as unsatisfactory.

An attempt was made to correlate the results with the type of car from which the samples were taken, but this was not fruitful of results. However, says the report, it is interesting to note that one of the lines from which a large number of samples was secured was able to show a correlation between unfavorable results and one particular car design.

The authors of the report believe that scheme has merit in determining roughly which railroads are giving sufficient attention to car and terminal sanitation and which are not.

FIG. 1. NEW METER SHOP AND GARAGE OF THE MINNEAPOLIS WATER DEPARTMENT

Meters in Minneapolis

W. W. DeBerard

Associate Editor, Engineering News-Record, Chicago

Well-planned routine of record-keeping, testing procedure and repair operations in a modern shop assures efficiency in meter-handling

FIVE YEARS AGO the Water Department of Minneapolis, Minn., recognized the need for new headquarters for the meter department and built a new building for that purpose a block away from the city hall in the gloomy inadequate basement of which the meter testing and repair work had grown up. With entrance into the new quarters, a one-story and basement structure, a progressive modernization of meter-handling procedure began. Record keeping was revised and simplified. A parts department was established which buys locally on specifications at wholesale prices lower than any manufacturer will bid. While the department can make meters at one-third less than the ordinary bid prices it has continued to purchase meters as heretofore. All meter patents expired years ago so that meter makers have only price, quality and service advantages over any well-equipped machine shop. From a recent inspection of the Minneapolis meter department the following notes were made on its general operation.

The building in which meters are tested has a 66-ft. office front on Third St. The lot runs 155 ft. through to Fourth St., the back end of which is used as a receiving areaway and parking space for plumbers' trucks and department cars. Plumbers bring in many meters for repair, since the customer owns and is responsible for his meter and must pay for repairs, although the work is done by the water department. On the first floor, which has a truck entrance door from the areaway and a trolley hoist running the length of the shop, are located three single testing machines taking meters up to 2 in. and an assembled tester taking larger sizes.

The test machines are in the center of the room and the work benches for testers are on the side in front of large factory-type windows. Partitioned off on the opposite side are storerooms for parts, locker room and a storekeeper's office where accurate records are kept in a perpetual inventory card file system. At the truck entrance is a receiving clerk's counter. Meters are unloaded onto warehouse trucks having four 3x6-ft. platforms one above the other.

Through the shop

Perhaps the easiest way to tell the story of meter-handling procedure is to follow a meter through the shop in its journey from private premises back to place again.

Meter readers work continuously and go over the whole city once every quarter, setting down their readings from the bottom of the page up and immediately subtracting from the previous reading to get the quarter's consumption. If the consumption appears out of line, the meter does not register or there is leakage evident, the reader so notes it on his sheet, which is kept in the collection office (in city hall) where it is used by the clerks for triplicate billing purposes. If the meter is stopped, for instance, a meter removal "pull" order is written in duplicate on a

white thin sheet and on a red file card. Both order and card are sent to the meter department, where additional information is added from a card in a history file in which all previous records of that particular meter are entered. These original cards play an important part in the simplified system, since they stay with the meter during its passage in and out of the shop and finally go into a record file.

For meter handling the city is divided into three districts, each of which is subdivided into eight groups, with a meter puller and setter assigned to each group. Each district is worked on for a month's period and is so arranged in time to follow the month the readers have been at work in that district. Thus the whole city is covered every quarter. As the meter pullers are rotated in these groups, eventually they become familiar with the whole city. Except for downtown and specials, groups cover a strip about 6 blocks wide and 25 long. Each district is about 8 sq.mi. in area and contains 31,000 meters. If a puller completes his assignment before his fellow workers have finished on their assignments he assists them in completing their quota. In any case, work in one district is completed before the next one is started. One man is assigned for large meters and special emergency cases.

A whole month's work of say 150 pull orders is arranged in accordance with street numbers and a white record separated from the red or shop card. A file for work orders for all the outside men is maintained near the door of the shop. On receipt of his white cards the puller goes over the list and checks the order and then proceeds to remove meters as he goes along.

When a meter is removed a nipple is inserted in its place. Often meters must literally be dug out of debris, but this covering frequently serves the useful purpose of preventing freezing. In the majority of cases full basements under houses are the rule, making it possible to place meters in desirable and favorable settings—meters are set high above the floor, for easy reading and out of danger of flooding.

A white tag showing the name of the puller and the address from which the meter was taken, is attached to the meter. In recent years red tags

Bill No. / Dated — **METER REMOVAL ORDER** — Dated 9/3/1937. — Shop Card 26583 Dated 9/30/1937.

Name John C. Jones.
Address 5752 So. Dupont Ave.
Mail To
Code 1B07-1

Reported by Office. Reason Stop. %
Size 5/8 Make Nash Type A Number 1258622

REMARKS	MATERIAL	COST	
	Disc HW.		85
	Train.	1	60
	Gasket.		05
	6 Bolts-Nuts.		15
	TOTAL MATERIAL	2	65
	Labor	1	00
	Total	3	65

Reading In 73500 Date 9/29/1937.
Reading Out " Date 9/30/1937.

Rem'v'd By Hastert. Test 309 Rep. Man. Martin.
Set By By CAR. Foreman

Fig. 2. Original meter removal order in duplicate carries record through shop and finally furnishes information for history cards.

Location 5752 So. Dupont Ave. — METER HISTORY CARD

Size	Make	Model	Meter Number	Connections	Date Sold	Application No. / Price
5/8	Nash.	A.	1258622		9/22/1916.	80324 / 9.50

Date Mo.	Day	Year	Cost of Repairs Labor	Material	Total	Shop Card No.	Reason for Repairs	Test Size of Orifice	Reading In	Reading Out	Storage In	Storage Out	Active Meter Years
9	30	1937	1.00	2.65	3.65	26583	D. Tr. Ga. 6RN.	309	735 00	" 00	Hastert-Martin.		
									00	00			
									00	00			

EQUIPMENT RECORD — ACME 11847

Purchased From — Date — Invoice No.
Purchase Price — Initial Freight — Erection Cost — Total Cost — Weight (Lbs.)
Estimated Life (Yrs.) — Annual Depreciation — Estimated Salvage — Job Rental Rate — Rental Rate to Lessees
Manufacturers Name — Serial No. — Condition at Purchase, Age, etc.
Remarks

INVENTORY RECORD

Date	Remarks	Annual Depreciation	Inventory Value	Date	Remarks	Annual Depreciation	Inventory Value

Fig. 3. Meter history cards which are filed by street location (top), and the equipment and inventory record.

have been attached to all meters as they leave the shop giving the meter number, size, make, and date of accuracy test on one side and address, reading "out" and puller's name on the other side. These tags carry a printed warning to the householder not to disturb, not to apply heat if frozen and to shut off the valve in case of leakage and to notify the department.

Returning to the shop with the day's "take," the puller unloads his meters in a group onto a truck. The receiving clerk immediately reads the meter dials and reports this reading to the collector's office for check with that of the last reading by the meter reader. The latter is noted in the reader's book. The puller returns the white removal order to the meter superintendent's office without notation if everything is regular.

If, for instance, he cannot get into the premises after one or two calls this fact is noted in the remarks column of the order and turned in to the meter office which immediately sends it over to the collector's office. From here a letter is dispatched to

Fig. 4. Looking into the shop from the truck entrance where meters are unloaded onto warehouse trucks.

the owner, carbon and original order coming back to the shop and the latter attached to the shop card. Ten days leeway is given before a shut-off order is issued.

Test and repair work

Arriving at the shop, meters are first taken into the basement for disassembly. The parts are put into a wooden tray, cleaned and passed through a bath of acid, then rinsed and brought back to the first floor to the end of the tester's bench. The white cards, which meanwhile have been in the shop office, are placed in a tray face down, and the individual repairman when he is ready to test and repair another meter takes the card on top and then gets the meter which the card calls for.

When repairs are completed the repairman notes parts and labor on the white card and also notes the meter record on his own daily report for use of the foreman. A rough test is made and the meter then goes to the head tester, who changes gears if the reading is more than 3 per cent off. If the cost of repairs, labor and material exceeds $4 the foreman is called in and usually condemns the meter. In these cases the customer is notified to purchase a new one. The consumer has no choice, but must take what the department has in stock, which is billed out to him practically at cost.

The head tester notes on the white card results of his tests, the actual figure being the weight of a 10-cu.ft. run. At this point the white card is removed from the meter to the office and a red tag made out and substituted for it under the lid over the dial. The meter is then sent to the painter, who applies a bronze paint with a spray gun in a small cabinet with exhaust fan, checks the reading and notation on the red tag, and ties this to the meter. Now the meter is ready to be returned and reset, which is done by the same man who removed it. If normal, the group of meters should be intact and come out of the shop ready for reset about a week after going in. About 60 meters go through the shop every day.

The labor and material items on the white original card when it comes from the shop are priced and the items added on the red card. The red card (not to be confused with the red tag) is returned to the collector's office for billing and filing. The record on the white card is transferred to the meter history card. All files are by street and number. Before they are filed the white cards are used by the superintendent in making up a daily meter shop report of material and labor for each of the ten kinds of meters and work of each repairman. These records are assembled by months, from which the year's record is quickly made up.

The average number of meters pulled and put through the shop in the three years prior to 1936 was 11,434, a figure increased to 14,80[illegible] or nearly 30 per cent increase in 1936. Some 544 less were repaired this difference representing meters condemned. The 1936 average cost per meter was $4.03, a reduction of 12.2 per cent over the previous 3-year average. The number repaired monthly varies from 1,000 in the vacation months to 1,479 in March following the winter casualties.

Parts department

The storekeeper has tiers of steel bins for parts, which include everything from cork and rubber bearings to assembled gear trains. With the exception of the porcelain dial faces every part is made in Minneapolis. Certain parts are chromium plated; monel metal is used in certain spindles. Tests to destruction indicate that meters assembled from parts made locally stand up longer than new ones.

As the storekeeper passes out small parts he notes them in a day book and at the end of the month assembles the figures for entry on the inventory card. To save counting when numbers of units exceed 50 he has stock bins with definite full numbers in them, packages so to speak, although they are not wrapped or boxed. When inventories get low as noted on the inventory card and orders have been placed, a red clip is slipped over the card, which serves to indicate when orders are slow as well as that the order is on the way.

An inventory is also kept of all equipment with the original price and annual depreciation noted. This record facilitates the annual January inventory and also provides comparative data for subsequent purchases.

Albert Thompson is foreman in charge of the division of meters and meter services and Fred Dymoke is storekeeper. The meter division is one of five divisions into which the activities of the waterworks department under J. Arthur Jensen, supervisor and waterworks engineer, are divided. The other four divisions are pumping stations and power, filtration and purification, distribution and service and office and meter reading.

Sunshine and Alga Control

R. F. GOUDEY

Sanitary Engineer, Bureau of Water Works and Supply, Los Angeles

Control of taste-and-odor-producing organisms and reduction in treatment costs made possible by charting ultra-violet ray activity

Of great significance in water treatment practice are the findings set forth by Mr. Goudey who, for the first time, tells of his studies correlating ultra-violet ray radiations with alga growth in reservoirs. Savings of 20 per cent in chemicals, and more positive control of taste and odor organisms have resulted from the application of these findings. Development of this technique puts a new tool in the hands of the waterworks man for quality control—EDITOR

PRESENT practice in treating reservoirs with copper sulphate or chlorine for alga control is to determine by laboratory analyses when certain types of microscopic organisms gain ascendancy and reach predetermined limits. This procedure has not been satisfactory because what might be considered a safe limit under certain conditions proves at times to be entirely too high. Likewise, while waiting for certain growths to reach fixed limits they frequently and suddenly get out of control. One of the most perplexing problems in treating reservoirs is still the determination of the proper time when treatment should be administered.

From the layman's standpoint, microscopic growths are supposedly at a maximum when water temperatures are high, hours of sunshine are long, and mineralization is at its height. It has been very puzzling to note that periods of greatest alga activity do not in most instances coincide with these factors. In searching for a possible explanation an attempt was made to correlate periods of alga activity with the ultra-violet ray radiation from the sun. As early as 1935 a study of these factors indicated that periods of greatest microscopic growths in reservoirs occurred at times when the ultra-violet radiation was at its greatest amount and all the other factors were below their maxima.

The comparison between solar radiation and the microscopic catch averaged for some thirteen large reservoirs on the Los Angeles system is illustrated in Fig. 2. It is to be noted that the maximum spring growth of alga in 1935 occurred in the middle of March at which time ultra-violet ray radiation was at its maximum. The water temperature during March was the coldest of the year, averaging 55 per cent below the average. Also, during March the per cent of sunshine was 94 per cent of normal. The per cent of possible hours of sunshine was 64 per cent. The lowest alga growth and also the lowest ultra-violet radiation was during June and July at which time the water temperature was highest, and the hours of sunshine and per cent of possible hours of sunshine were greatest. This correlation was so striking that it warranted further investigation.

The following discussion deals with Southern California conditions which are probably different than elsewhere. During the year 1936-37 the maximum growths in reservoirs coincided with the period of maximum ultra-violet ray activity in May which also was the period of least water temperature and hours of possible sunshine. In 1937 the greatest activity was in April. There is a second peak in radio activity and alga growths in the fall, usually November or December. A closer study of the data indicates two active periods; one occurs in the spring months when the atmosphere is clear and all nature starts its growing season, and the second occurs in the fall after the first winter rains. The growth of plant life in water is parallel with the increased tendency for land plants to thrive.

Few troubles are experienced from the beginning of May to the end of August because during the summer there is much less solar radiation and, in addition, the haze in the

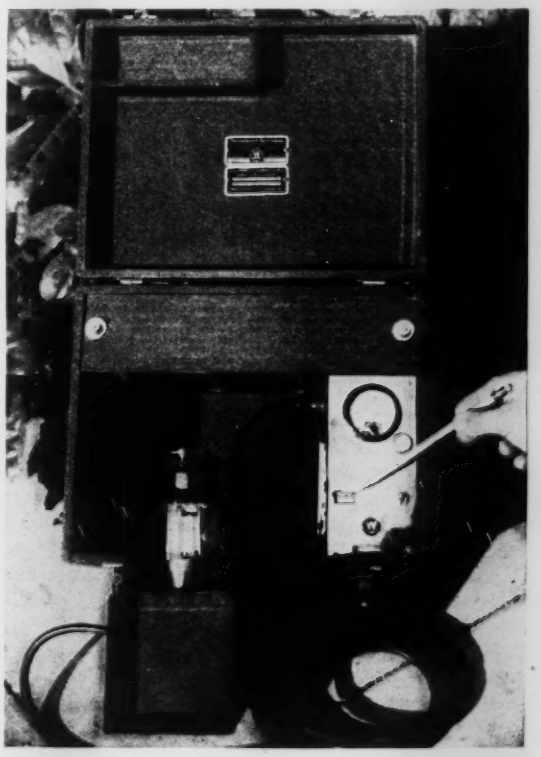


Fig. 1. Ultra-violet ray measuring device. The photocell is shown at the lower left.

sky makes it difficult for ultra-violet ray emanations to reach water surfaces. In the fall, however, the atmosphere becomes clear, ultra-violet ray intensity is on the increase, and microscopic growths then become troublesome. The periods when copper sulphate is used to destroy algae corresponds with these variations. The heaviest usage of copper sulphate coincides with the spring period of solar radiation. September is the month when the combined factors of water temperature and hours of possible sunshine are at their maximum and yet, during this month, less than five per cent of copper sulphate applied in a year is used.

During 1935-36 all ultra-violet ray measurements were obtained from data furnished by the California Institute of Technology. In July, 1936, two ultra-ray measuring and recording devices were purchased to carry these studies further. While this research is still in a preliminary stage and definite conclusions as yet cannot be reached, it is hoped that workers elsewhere will be interested in making correlation studies of ultra-violet activity and alga growth.

The simplest type of radiation recording apparatus is that furnished by the Westinghouse Co., consisting of a portable cabinet containing a photo-electric cell sensitive to ultra-violet radiations in the range from 2700-3600 Engstrom units. The cathode material in the sensitive cell is thorium. The recording device consists of a counter operated by a battery current from a condenser which breaks down each time the current on the photo-electric cell breaks in its condenser.

The total number of counts per minute is a relative measure of the ultra-violet ray radiation. Manual readings from such a machine must be made at frequent intervals during the day in order to observe variations.

The second machine which was purchased was a photo cell of similar sensitivity but directly connected with a recording meter which gives a continuous curve for the ultra-violet ray radiation. The photo tube for the recording unit is housed in a cell containing a quartz plate window and the cell is mounted on clock mechanism so that the window is always pointed at the sun. Details for the best type of this setup have not yet been completed. The recording device consists of a recording galvanometer actuated by the photo-electric cell current direct. The chart reads from zero to 50 microamperes. Neither of these two units have as yet been standardized for known sources of ultra-violet activity and the readings which they give are only of relative value insofar as they vary above and below average readings.

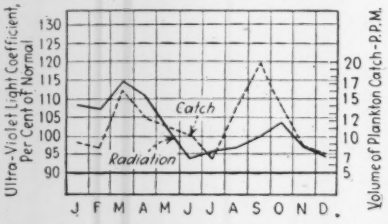


Fig. 2. Relation between solar radiation and plankton in reservoir.

It is our aim to obtain 24 hr. continuous readings at one reservoir throughout the daylight hours and determine accurately the variations between all known factors entering the problem. The portable unit is carried from reservoir to reservoir to pick up effects of fog, differences in elevation, geographical variations, and other factors.

Fog, haze, and clouds absorb radiation noticeably. Even though sun spot activity may be high it does not follow that radiation at the water surface is also high. The amount of daily variation is 100 per cent plus and minus of the average, and hourly variation on the minus side is even greater. For instance, the number of counts per minute will vary on a foggy day from 1/6 to 14 on a clear spring day. This gives a wide variation with which to correlate other data.

Sun spot activity

In tracing the ultra-violet ray activity closer to the source, equipment has been secured to study sun spots. It consists of a ground sun lens 8 in. in diameter having a focal length of 44 ft. A white disc is mounted on a suitable standard which shows the sun's image in about a 4 in. diameter disc. Sun spots are clearly visible on it and are counted in number. The sun spots are divided into three classifications according to size, namely, 0 to 10,000 miles in diameter; 11,000 to 50,000 miles, and over 50,000 miles. The spots appear on the lower right hand quadrant and gradually travel across to the upper left quadrant. A large sunspot of 100,000 mi. dia. entering the lower quadrant usually sets up a period of excessive ultra-violet ray radiation.

The object of studying ultra-violet ray activity now is to determine first, whether ultra-violet activity is on the increase or decline. If it is on the increase, copper sulphate and chlorine will be applied at lower microscopic counts than heretofore, and the greater per cent of copper and chlorine used during the year will be administered during the period of greatest ultra-violet ray activity. Likewise, if the radiation is on the decrease and even though the microscopic counts are somewhat high, treatment will be postponed.

Thus far, application of this new principle has been of great value. Not only has there been a saving of 20 per cent of the chemical used in treating reservoirs but the water served to consumers is of a higher quality judged by its freedom from tastes and odors.

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Atlanta Waterworks Improvements

A WATERWORKS improvement program contemplating the expenditure of $1,250,000 during the next five years has been started in Atlanta. The purpose of the program is to extend plant facilities to meet present needs and also to provide for future increases in consumption. During the peak load of last summer, the filtration plant with a normal capacity of 39 m.g.d. was forced to operate at a 50 m.g.d. rate.

The new work will include the construction of two additional sedimentation basins equipped with mixing equipment, a 32 m.g.d. extension to the present filters, the installation of new supply and discharge lines, and enlargement of pumping facilities. Funds will be obtained from revenue specifically allocated to waterworks improvements by a recent act of the state legislature.

Construction of the sedimentation basins is now underway and it is expected that they will go into service in July in time to assist the plant in carrying the peak summer load. Wiedeman & Singleton, Inc., of Atlanta, are the consulting engineers.

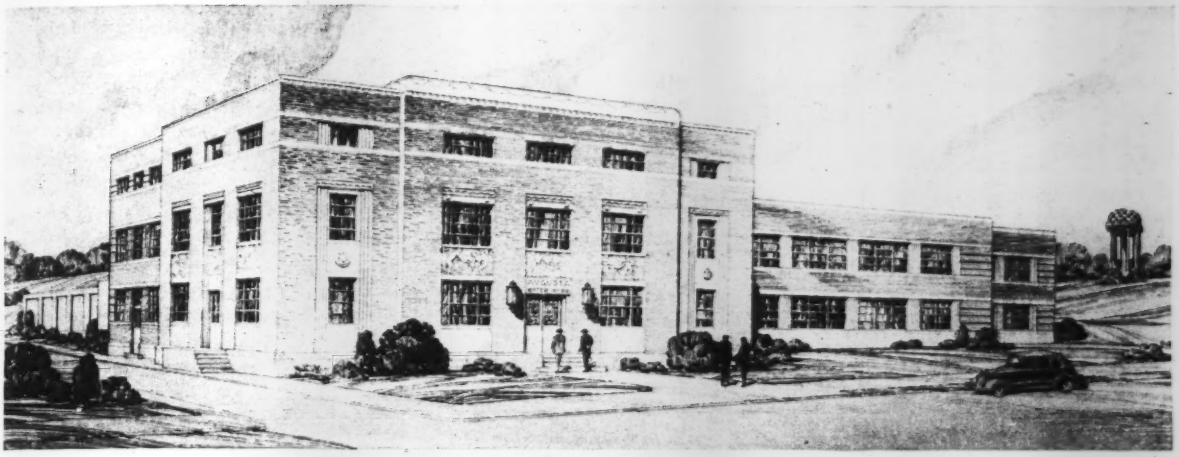


FIG. 1. BRICK AND LIMESTONE BUILDING WHICH WILL HOUSE THE TREATMENT PLANT

Augusta's New Filter Plant

R. E. IRVIN,

Assistant Manager, Municipal Engineering Department, Robert & Co., Inc., Atlanta, Ga.

Use of concrete box flumes instead of pipe provides water conductors which also serve as wall structures and thus cut construction costs

TO SUPPLANT water treatment facilities that have given almost a half century of useful service, a filtration plant is now under construction in Augusta. This new 15 m.g.d. plant with its special provisions for pre-treatment of the turbid water of the Savannah River embodies a number of interesting design features. Prominent among these is the use of concrete flumes instead of pipes, which not only serve to conduct water but act as wall elements in the structural design as well. In addition, automatic control devices for feeding chemicals and operating valves have been extensively employed to insure good operation.

For a proper understanding of the water supply problems of Augusta, it should be recalled that the city is on the banks of the Savannah River, some 130 miles upstream from the point where it empties into the ocean. Although extremely turbid the Savannah River has an abundant flow at Augusta (2,000 sec.ft.min. estimated) and since this water is very soft, it serves as an excellent source of supply.

Augusta's first water system, constructed in 1818, consisted of wood pipe lines which connected with springs. The wood pipes were made by boring out the centers of logs which were laid end to end to form a continuous channel. In 1845 a dam was built about seven miles upstream from the city, and a canal was constructed to convey water into the city for the production of power in industrial plants. The availability of this cheap power led to the establishment of a pumping station on the banks of the canal in 1884.

In 1898 a water treatment plant was constructed some four miles from the river; this consisted of basins with combined capacity of 125 m.g., a filtration plant equipped with ten 1-m.g.d. circular steel tub filter units, and a circular brick clear well of 1.5 m.g. capacity. The present facilities include the pumping station which is equipped with two double-acting, plunger-type pumps, each driven by a horizontal waterwheel, a 30-in. c.i. main from the station to the filter plant, centrifugal pumps for high service and a 500,000 gal. elevated tank for the high section. All of these structures, with the exception of the elevated tank, have been in service for 40 years and improvements were sorely needed.

In a recent report on conditions the consulting engineers recommended enlargements and changes which would eliminate the possible danger of contamination of the supply due to the general poor physical condition of the plant, and would also provide adequate filtration and storage capacity. Population and water consumption curves showed that the filter capacity should be increased to 15 m.g.d., and clear well storage increased to at least 4,500,000 gal. to care for estimated demands during the next twenty years.

The new plant

On the basis of these recommendations a new plant is now under construction on a site adjacent to the present plant. The design calls for the utilization of the existing raw water storage basins and clear well

as supplementary units in the new layout. Raw water will flow by gravity from the storage basins to a primary mixing chamber of the over-under baffle gravity type. The chemicals will be applied at the inlet of this chamber and flash mixing will take place in a detention period of one minute at a velocity of 1.45 ft. per sec.

From the primary mixing chamber the water will flow into a secondary mixing or flocculation basin, equipped with mechanical agitators. This basin, divided into two parts for flexibility, provides a detention period of 30 min. Two coagulation basins with a combined detention period of 4 hr. are also included.

Five rapid sand-type filters will be provided, each with a capacity of 3 m.g.d. at the rate of 2 gal. per min. per sq.ft. The filters will be housed in a brick and limestone building of modernistic design which will also include the following:

First Floor: Lobby, pump room, pipe gallery, meter room, shop, toilets, and boiler room.

Second Floor: Filters, operating floor, office, laboratory, chlorinator and chemical feed rooms.

Third Floor: Storage space for seven cars of chemicals.

The primary mixing chamber is at such elevation that gravity flow through a 30-in. line is available from the raw water basins. To control the flow into the plant, a combined 30 x 16 in. venturi tube and 16 in. hydraulic control valve will be installed in the 30-in. line.

The cone valve will be controlled by a 4-way hydraulic transfer switch located in the filter plant at a point directly below an indicating raw water meter, which is actuated by the venturi tube. With this arrangement the rate of flow into the plant can be readily coordinated with changes in the rate of filtration.

Design studies indicated that a considerable saving could be made by using concrete flumes as conductors for the water between the various structures and also for waste water and drain conductors. The general arrangement of the flumes is shown in Fig. 3.

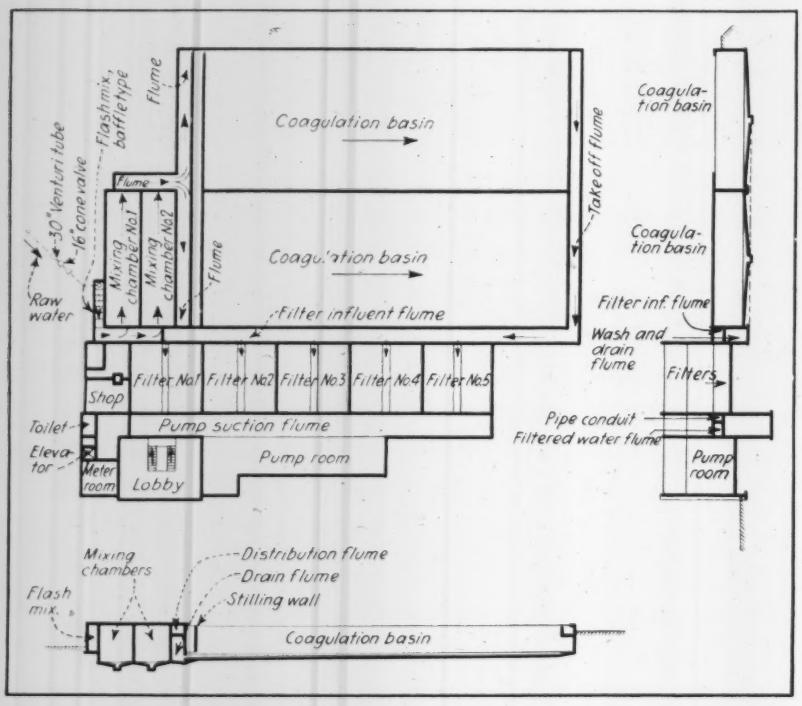


Fig. 3. General layout of the treatment plant.

Flume design features

In order to describe the function of each flume it is desirable to trace the flow through the plant from the mixing chamber to the pumps. Water containing large particles of floc will travel from the secondary mixing chamber to the coagulation basins in a flume 8 ft. wide by 4-ft. deep, in which the velocity is 0.72 ft. per sec. Where the flume enters the distribution flume of the coagulation basin, half of the flow must make a 90 deg. turn to the right and the other half turns 90 deg. to the left. Aluminum straightening vanes will be installed at these turns to prevent turbulence and subsequent floc breakage.

The distribution flumes have an area of 24 sq.ft. giving an average flow velocity of 0.48 ft. per sec. Water leaving these flumes enters the coagulation basins through adjustable aluminum gates, passes through a concrete stilling wall and then through the coagulation basins at a velocity of 0.13 ft. per sec. Settled water leaving the coagulation basins is taken off near the surface and collected in a flume with a cross sectional area of 20 sq.ft. when the average velocity will be 0.58 ft. per sec. This take-off flume connects to the filter influent flume in which the velocity is 1.16 ft. per sec. before filter No. 5 is reached, and from that point the velocity is gradually reduced to 0.23 ft. per sec. immediately after filter No. 2.

Filtration unit details

Water reaches the filters from the influent flume through 24-in. square sluice gates, and is distributed over the filter area from a forebay in the center of each unit. Each filter is divided into two equal parts by the forebay, and the wash troughs drain across each half into the forebay. The uses of a separate manifold and lateral system and the arrangement of piping is such that each half may be washed separately.

When the washing of a half unit is in process the waste water flows into the wash troughs to the forebay, and from the forebay through a 24-in. square sluice gate into the waste flume and thence into the plant sewer. The waste flume, connecting with a 36 in. sewer, is directly under the filter influent flume. This gives a two-story flume which, it will be noted, not only takes the place of a cast-iron influent pipe and a waste water sewer but also serves as walls for the coagulation basins as well as for the filters.

Filtered water is collected in a cast-iron effluent header, and after passing through a 16-in. rate controller, is

discharged into a concrete effluent flume located directly under the pipe gallery floor. This in turn is connected to the clear wells by 30-in. cast iron lines. A pump suction flume is provided directly under the filter effluent flume. This two-story flume takes the place of a large cast iron filter effluent main and a large pump suction header and in addition, serves as a substructure for portions of the filter building.

For draining the mixing chambers there is a trough in the floor through the center of each of the chambers beginning at the upper and with a depth of 3-in. and sloping to a depth of 12 in. at the lower end. There is a slope of 12 in. in the floors from the walls to the center troughs. These troughs terminate at sluice gates which discharge into concrete drainage flumes. This same system is applied for draining the coagulation basins, with the trough 12 in. deep at the upper end increasing to a depth of 24 in. at the lower end.

Experience has shown that a large percentage of the suspended matter will settle out by the time the water has traveled about one-quarter of the length of the coagulation basins, thus most of the sludge will be deposited in the low end of the basins near the drain sluice gates. Since this is the point of maximum velocity during draining, and since practically all of the water must pass through this heavy deposit area, it is believed that the drainage operation will remove most of the sludge.

Valves and meters

The operations of filtering, washing, and rewashing of each filter unit will be controlled by seven hydraulic gates. In addition to the 24-in. influent and waste sluice gates there will be two 16-in. filter effluent valves, two 18-in. wash valves, and one 8-in. rewash valve. All of these will be controlled from seven valve-operating tables.

All of the meters in the plant will be mechanically operated, indicating, recording, and totalizing instruments, actuated by venturi tubes.

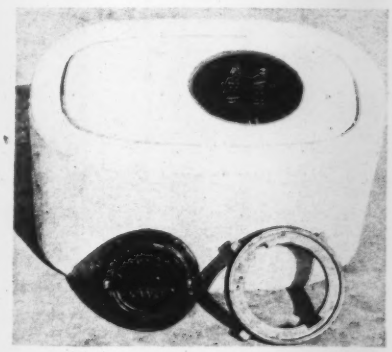
Five gravimetric chemical-feed machines will be provided. The charging hoppers will extend to the third floor. Two of these machines will feed alum, two will feed lime, and one will feed carbon, lime, or sodium aluminate. The machines will be arranged for automatic proportional control, the proportioner being actuated by connection with the raw water venturi tube. Two new automatic solution feed chlorinators, together with flush mounted chlorine scales will be provided, and an existing ammoniator will be changed to automatic feed. The chlorinators and ammoniator will also be actuated by the raw water venturi tube.

Fig. 2. Driven by waterwheels, these pumps lift the river water to the treatment plant 4 mi. away.

The Augusta project is in charge of E. E. Pund, commissioner of public works and city engineer, and Marion B. Cooper, superintendent of canal and water works. The plant was designed and construction is being supervised by Robert and Company, Inc., architects and engineers, Atlanta. The contract for the structure is held by Batson-Cook Co., West Point, Ga., and for the mechanical work by the MacDougald Construction Co., Atlanta.

Tamperproof Meter-Box Covers

THE FREQUENCY with which children and other unauthorized persons removed the centerpieces in concrete meter boxes, thereby creating a hazard for pedestrians, made it necessary for the water department in Los Angeles to design a concrete cover in which a cast-iron seat for the centerpiece was cast into the concrete. The metal ring or top rim of the seat has two slots; similarly, the centerpiece has two lugs which pass through the slots in the seat. After being passed through these slots a one-quarter turn on the centerpiece puts the lugs in contact with stops under the rim of the seat and wedges them tightly. Risk of removal of the centerpiece is reduced by the requirement that it must be rotated before it can be lifted out. To remove the centerpiece the meter reader carries a key fitting the two holes.



Concrete meter box with a metal seat for the centerpiece cast in the concrete cover.

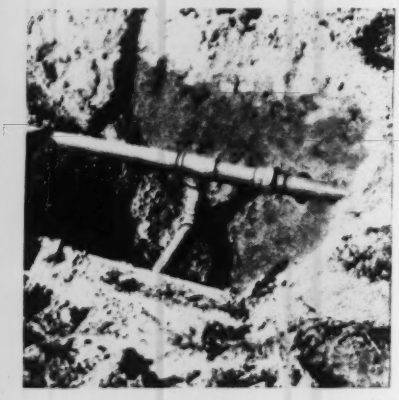
It is the intention of the water department to standardize on meter boxes of this type for meters set in parking lawns. Each box is to be large enough to afford space for changing the meter after removing the concrete cover in which the centerpiece is located.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

One Way to Steal Water

Clever use of a tee connection installed to look like an ordinary coupling was the means by which water was stolen from a metered municipal supply without detection. For more than a year water officials were puzzled over the low consumption at an establishment served with a 1¼-in. pipe, but surveys failed to reveal any irregular connection. Finally, it was decided to uncover the supply pipe and thus it was that a fitting became exposed.



Tee-fitting, disguised to look like a coupling connection, taps water pipe.

At first glance it appeared that this was nothing more than a coupling but upon further examination beads were noted on each end, such as appear on tee fittings. Excavation below the pipe proved this to be the case (see illustration) and showed how a branch line was attached to bypass the meter.

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A Sewer Trap Sampler

In Los Angeles, city ordinance requires the installation of traps in sewer connections of industrial plants, but where excess quantities of waste are discharged continually the traps soon fill and become ineffective until cleared out. A ½-in. glass tube is used to sample the material in a grease trap before it is cleared of its accumulation. The tube, open at both ends, is inserted to the full depth of the trap and then a cork is placed in the top of the tube before it is withdrawn. Just before the lower end of the tube is pulled clear of the trap contents another cork is inserted at the bottom, thus preventing the escape of any part of the sample within the tube. After the outside of the tube is wiped clean a true cross-section of the contents of the trap is shown, even indicating the depth of the varying substances deposited. This sample is a convenient exhibit for use in discussing the situation with the owner of the plant from which the waste comes. The result has been greatly improved cooperation in industrial waste disposal, thus decreasing the cost of sewer maintenance considerably.

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Dolly Bench for Welding Hydrants

An old story to many, but new to others, is the repair of water hydrants by bronze-welding. A new hydrant costs about $80. In years past, a damaged hydrant was worth about 50c. as scrap. Today, it is reclaimed for a very small fraction of the cost of a new one. What makes such work of special interest is the fact that in at least one shop it has been set up to be done on a production basis in order to reduce the costs to the minimum.

In the waterworks department of one city, fractured hydrants are arranged on two tables, each provided with dollies or rollers on which the hydrants can be turned to facilitate welding. In some cases a length of pipe is used as a sleeve and bronze-welded to the remaining parts of the hydrant at each end. Occasionally, parts from two or more badly damaged hydrants on which individual repairs are impossible, are combined to make one good hydrant.

Bronze welding is likewise used to lengthen hydrants taken out of service because they are shorter than standard. Instead of scrapping them, they are lengthened at a small cost, and placed in stock for further use as required.—LINDE AIR PRODUCTS Co., *New York.*

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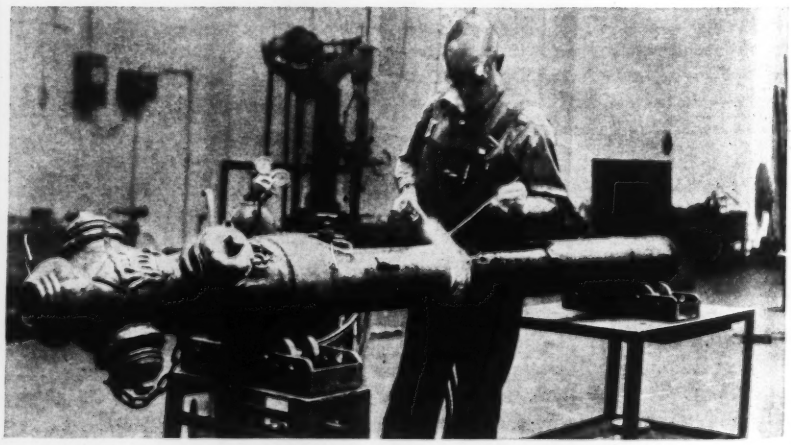
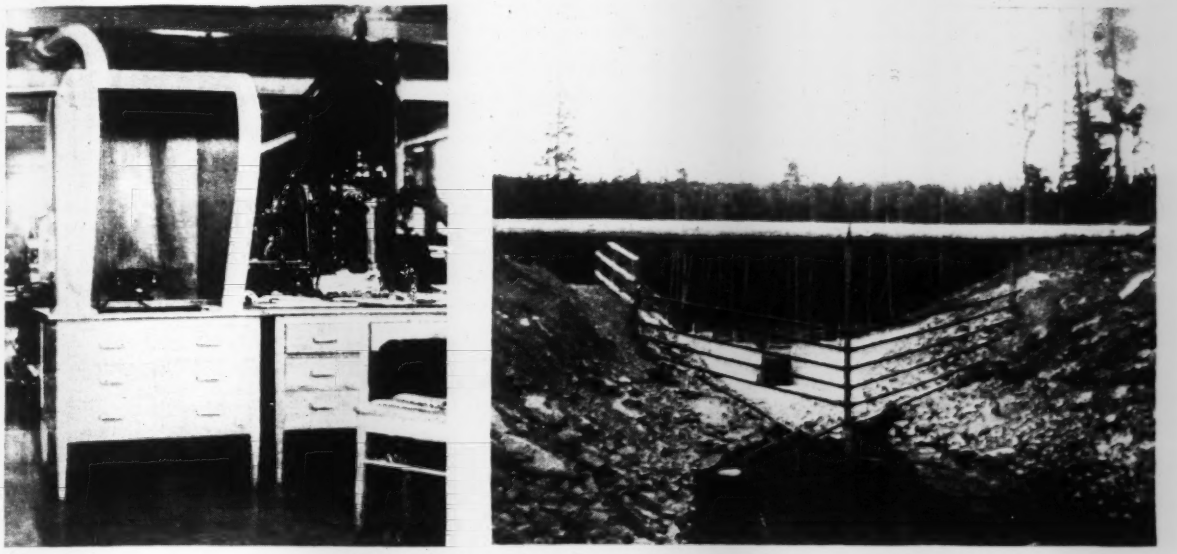
Clay Cauking Stops Tank Leak

When wood-stave tanks dry out, or when old tanks of this type are reassembled after moving, leaks that are hard to stop may develop at the joint between the boards of the tank bottom and the staves that constitute the wall. Leaks of this sort occurred when a 50,000-gal. redwood tank about 30 years old, owned by the Marin Municipal Water District in California, recently was taken down and moved to a new location where it was erected and put in service. The leaks were stopped effectively by a clay filler applied as indicated by the accompanying sketch.

A good quality, uniform clay free from foreign material was mixed with just enough water to bring it to the consistency of thick putty. Opposite each leak a ¾-in. hole was drilled in the tank stave and was made deep enough to reach the end

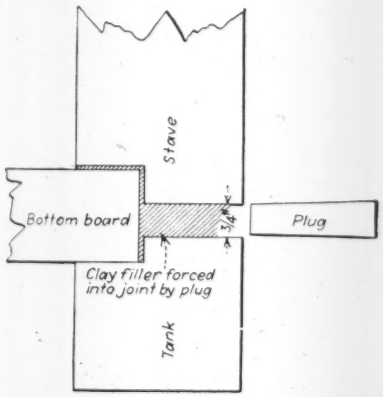


Hydrant on dollies can be easily rotated for welding breaks



CAMERA MEMORANDA OF WATER SERVICE AIDS

Two quite different devices but both parts of city water-supply service are illustrated here. On the left is shown the accoustical telephone booth at the operator's desk on the main floor of the Madison, Wis., pumping station. Pump noises are blanketed and the operator can clearly hear what any consumer may think of the service. The curious device shown on the right is a by-pass for deer on the Fraser River diversion conduit for the Denver water supply. Deer following along the flow of water were being trapped and drowned in the current at the portal of the siphon until this bypass was constructed.



Method of forcing clay into leaky joint between bottom boards and wall staves of wood tank.

of the bottom board. The clay putty then was forced into the hole by pushing and punching with a small dowel. Care was taken to work the clay in thoroughly while the hole was only partly full, thus forcing as much as possible into the narrow space between bottom board and stave. With the hole packed nearly full of clay a wooden plug was fitted carefully and driven in tightly.

This treatment entirely stopped the leaks, the clay did not wash out of the seam and eventually hardened giving a closure that is permanently tight. The tank was moved and tightened under the direction of J. S. Peters, general manager and chief engineer of the Marin Municipal Water District.

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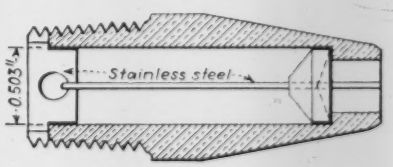
Jet Meter For Flush Tank

Automatic flushing of sewers once a day by water discharged from underground gravity-tipped flush tanks, frequently of 300-gal. capacity, is considered necessary in Los Angeles for ridding the sewers of accumulating solids, especially at the upper ends of laterals having flat grades. The operation of these tanks has been made more dependable by a jet meter developed in the water department for controlling the rate of flow into the tanks. Some 6,000 have been put in service and more are being installed.

Formerly the tanks filled through a faucet or through a small orifice drilled in a cap on a 1/2-in. pipe, but these devices required too much attention; the common trouble was plugging caused by algae growths and corrosion.

The jet meter, shown in Fig. 1, can be screwed into standard 1/2-in. pipe threads. The aperture through which the water flows is about 1/8 in., occupied in part by a hanging wire so that the water flows through the annular space around the wire. The jet meter is installed in vertical position so that the wire, hanging vertically downward, is free to be vibrated by the water jet and thus is brought into contact with the sides of the aperture occasionally thus preventing algae growths.

The major portion of the meter is cast of a composition of copper 84.5 to 86.5 per cent; zinc 6 to 8 per cent; tin 3.5 to 4.5 per cent, and lead 3.5 to 4.5 per cent. Across the top or head of the meter is a thin crossbar of stainless steel with a central hole through which a stainless steel wire is attached. The wire extends downward through an aperture in a disk made of hard rubber or stainless steel which is seated in the lower part of the meter. The assembled meter is $2\frac{5}{16}$ in. long and weighs 3.7 oz.



Parts and assembly of jet meter for filling sewer flush tanks.

Wells and Water Supply

J. G. GORDON, JR.
President, Layne and Bowler, Inc., Memphis, Tenn.

Current advances in well construction methods and the application of these improvements to installations in sand and gravel formations

WITH almost 45 per cent of the population of the United States depending wholly or in part upon well water it is natural that much thought has been given to methods of developing this importan source of supply. Efforts are constantly being made to improve methods of drilling, to provide safeguards against contamination, and to construct systems which will provide dependable supplies at low cost. It is the writer's intention to consider in this article some of the current advances in solving well installation problems, particularly where water is developed in sand and gravel formations.

The three outstanding developments in method are:

1. Perfection of underreaming processes, which are used both in shallow and deep well construction and which make possible the development of maximum well efficiency;

2. Improvement of gravel packing for gravel-wall wells which insure the positive gravelling of screens set in deep strata, and greater yields from the strata; and

3. Cementing of wells for permanence and safety.

A brief description of these developments will aid in understanding their application to well installations.

Underreaming—Two types of underreamers — mechanical and hydraulic — are in use. The mechanical underreamer is equipped with cutting blades which remain recessed in the reamer body until it is lowered to the stratum where the enlargement is to be made. The blades are then extended for reaming purposes until the bottom of the waterbearing stratum is reached. The hydraulic or jetting underreamer is applied in a different manner. It is lowered to the bottom of the waterbearing stratum where a large diameter hole is "washed out," and from there it is worked upward to the top of the stratum. Both reamers accomplish similar results.

In Fig. 2 it can be seen how proper underreaming makes it possible to drill to the waterbearing formation, set pipe or casing to that point, then finish and develop a large diameter gravel-wall well. Usually the area of the underreamed portion of the hole is several times greater than that of the casing set in the bore hole. For example, it is feasible to work through a 10 or 12 in. casing with an underreamer and cut a hole through the waterbearing formation as large as 30 in. in diameter. Several strata can be underreamed and developed in this manner and depth offers no real obstacle. Underreaming can be carried out in wells at depths of several thousand feet.

Fig. 1. The Houston water supply is obtained from 20 well plants similar to this installation

Gravel Packing—Crude attempts to increase well capacities by installing crushed rock or gravel around the screen tube date back seventy years. It was not until the turn of the century, however, that gravel packing was used to a considerable extent. Early gravel-wall wells were quite shallow and constructed by drilling a large diameter bore hole in unconsolidated formations, setting a small diameter well tube therein and pouring gravel around the tube hoping that it would settle around the strainer. Later the bailing process was used in shallow wells. An outer casing was set to the waterbearing formation and the screen then was bailed into place, gravel being fed around it during the bailing process. This method insures better placement of the gravel around the screen and results were greatly improved. The bailing process is still used to a considerable extent in some sections where underground formations are favorable.

Lately, gravel packing of wells has developed into an exact science. Perfection of undearreaming methods contributed materially to this since this operation solved the problem of making large size bore holes or openings through the waterbearing stratum regardless of depth without the necessity of drilling a large hole all the way down. New methods of gravelling have been devised which are entirely positive in action and by which a gravel envelope of uniform thickness can be placed around the screen throughout its length. This is accomplished by mechanical means or processes, some of which are patented. Successful mechanical gravelling of strata has been effected to a depth of three and four thousand feet, and there is no reason why it cannot be applied at any depth.

Among the many advantages of gravel-wall wells are: (1) retention of the sands making up the strata without movement into the gravel envelope during maximum pumping demand; (2) greatly increased specific capacity resulting in decreased pumping head; and (3) prevention of mineral or other deposits in screen openings.

Cementing—Use of this development in well construction is becoming the rule rather than the exception. Two reasons are responsible for this—sanitation and permanence. The cementing of casings, particularly at the lower end, has been done by oil field drillers for many years, but the practice of cementing water wells is quite recent.

With the latest and most approved method of cementing, cement grout is pumped through conveyor pipes placed inside the well casing and directed upward between the casing and the ground formations (walls of the borehole) until the annular space is entirely filled to the surface of the ground. When the operation is completed, the entire length of well casing is enclosed in an unbroken wall of cement, the thickness of which depends on the difference in diameters of the borehole and the pipe set in the well.

Viewed from the standpoint of both well contractor and owner, the principal advantages of cementing are as follows: (1) Prevents caving and sloughing in of the drill hole; (2) provides a permanent seat for the casing; (3) avoids possibility of returns (drilling fluid) passing outside the casing during drilling operations; (4) fills up cavities during drilling and tends to prevent crooked holes; (5) protects and strengthens the well casing, prolonging the useful life of the well indefinitely; and (6) prevents contamination by polluted surface waters, or undesirable water from upper strata, which may enter the well through openings or cracks in the casing, or by following the casing down to the top of the waterbearing formation.

Recent installations

Two installations have been selected as illustrative of the application of improved construction methods just outlined. One was made for the Blytheville Water Co. in Arkansas and the other at Houston, Texas. The latter is one of twenty similar units constructed for the city, which is the largest municipality in the United States depending entirely upon wells for its water supply.

The Blytheville water supply system includes a well, vertical turbine pump and direct-connected motor with control apparatus.

Well Construction — The well is 1,450 ft. deep; water is encountered at 1,310 ft. and continues therefrom to the bottom. In order to properly log the ground formations and thus determine the method of installation, a pilot hole was drilled with a 9-in. barium six-way bit. When the waterbearing sand was encountered, samples were taken and subjected to flow and sieve tests from which the percentage of voids was calculated. On the basis of these tests were determined the approximate yield of the finished well, the size, type and mesh of screen and the size of gravel best suited for the gravel wall. Although it was found that 60 per cent of the sand was 0.010 to 0.015 in. in size, the well when completed pumped no sand and the specific capacity was about 50 gallons per foot of drawdown.

The pilot or test hole then was reamed out to about 15 in. in diameter to the 1,300 ft. level. In this hole, accurately centered, was placed 1,300 ft. of 12 in. standard weight steel pipe. Cement grout was then pumped through a conveyor tube placed inside of the pipe. Sufficient pressure was maintained to move the grout through the tube and then out and up in the annular space between the pipe and the outside of the drill hole. This operation was continued until the grout appeared at the surface of the ground. The well pipe throughout its entire length was thus surrounded with a solid cement wall which filled all cavities formed during drilling operation. This provided insurance against any caving of earth around the casing, and completely and permanently sealed off all seepage from the surface or from strata other than the waterbearing sand. Over 700 bags of cement were used for this purpose.

After the cement had set the plug was drilled out of the lower end of the well pipe and the water bearing sand was then underreamed to 30 in. in diameter throughout its length with a mechanical underreamer. Following this a silicon bronze shutter screen, equipped with centering lugs, was installed in the waterbearing formation.

A gravelling machine of the hydraulic type was used for placing some 25 cu.yd. of graded gravel about the screen. This machine placed the gravel in layers around the screen working from the bottom upward.

Pumping Equipment — A vertical turbine pump equipped with a double wound, 25 60 hp., 1160/1750 r.p.m. weatherproof motor is used. The automatic starting equipment is operated by a float switch ordinarily, but manual control is also provided. During official test, the pump delivered 1,200 g.p.m. when operating at 1,160 r.p.m. and 1,860 g.p.m. when operating at 1,750 r.p.m.

Wells at Houston

The well installation at Houston is one of twenty which make available

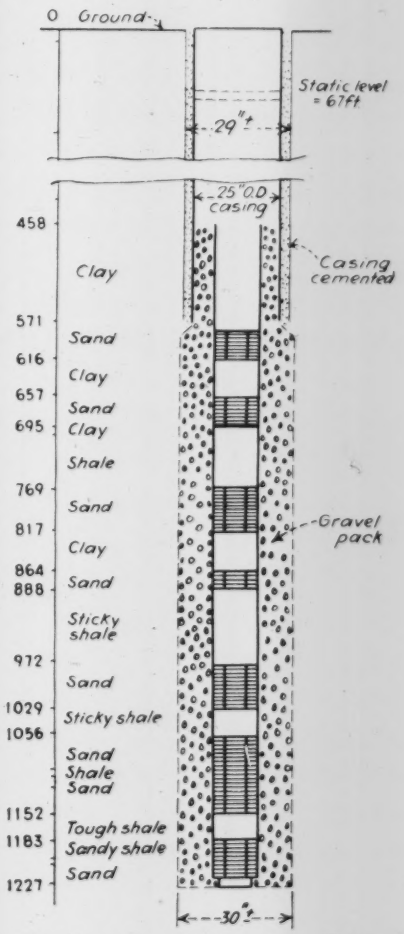


Fig. 2. Cross section of a Houston well which was underreamed and gravel-packed.

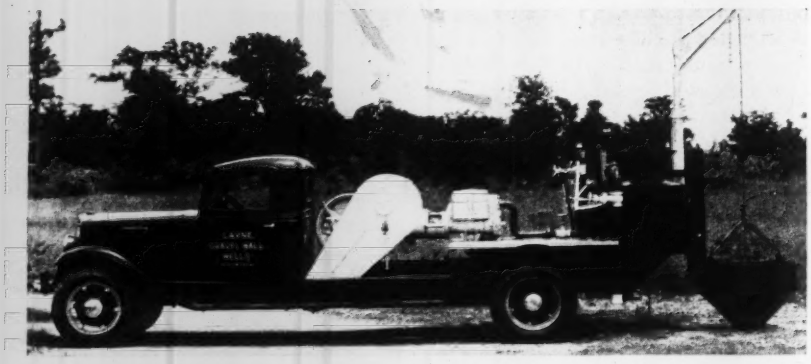


Fig. 3. Gravelling machine of the hydraulic type which has been used in wells 3,500 ft. in depth.

45 m.g.d.; three additional units now under construction will increase the available supply to over 55 m.g.d. The arrangement of well fields in Houston is unique in that they are grouped around seven pumping plants which are located on the circumference of a circle, with the central plant at the center. Thus the supply units are located near points of demand and uniform main pressure is maintained over the entire city. The unit to be discussed is typical of all the Houston wells.

Well Construction—A pilot or test hole was dug to a depth of 2,000 ft. and an accurate record logged of the depth, character and thickness of the various strata. Samples of sands from the waterbearing strata were analyzed to determine the flow, fineness of sand, porosity, approximate quantity of water which could be produced from the completed well and the type and mesh of screen. From these data it was decided to incorporate seven different waterbearing strata in the well. The first of these strata was encountered at a depth of 580 ft. and the last terminated at a depth of 1,227 ft. below the surface of the ground.

The pilot hole was reamed out to about 29 in. in diameter to a depth of 570 ft. and 25-in. pipe was set to that depth. Cement grout was then pumped under pressure into the annular space about the pipe in a manner similar to that used on the Blytheville job. This required 1,087 bags of quick-setting cement. After the cement had set, the plug was drilled out and the well underreamed from the bottom of the 25-in. pipe to a depth of 1,232 ft. or about 6 ft. below the bottom of the last waterbearing stratum. The well tube, made up of screen and blank pipe, was then installed. The 13-in. brass screen sections varied in length according to the thickness of the waterbearing strata in which they were set, and the seven sections used totalled 314 ft. The blank pipe set opposite the non-waterbearing formations was also extended upward in the 25-in. pipe for a distance of 114 ft. so as to form a lap.

Well-rounded and graded gravel was placed around the entire length of the well tube, beginning at the bottom and filling to the top. This was done with a gravelling machine which forces water, containing the gravel, under high pressure through conveyor pipes extending from the surface of the ground to the particular portion of the screen being gravelled. The process used prevents any bridging and insures proper coverage of all screen. This is extremely important as an ungravelled portion of screen would permit the fine sand from the stratum to enter the well. Should this occur it would cause the formation of a cavity, ultimate caving and breaking down of the formation, and possible collapse of the strainer or casing with loss of the well.

After gravelling, the well was developed in the regular manner by bailing, swabbing and washing. When tested, it produced 2,595 g.p.m., the specific capacity being 46.8 gal. per ft. of drawdown.

Pumping Equipment—This consists of a 4.75 m.g.d. vertical turbine pump which lifts the water from a depth of about 190 ft. and delivers it at the surface of the ground. There it is picked up by booster pumps and delivered into city mains. The turbine pump is driven by a 150 hp., 1,200 r.p.m. synchronous speed motor.

At Blytheville the well was constructed and equipment installed by Layne-Arkansas Co., turbine pump and shutter screen was furnished by Layne & Bowler, Inc., and electrical equipment by the General Electric Co. At Houston the well was constructed and equipment installed by Layne-Texas Co. turbine pump was furnished by Layne & Bowler, Inc., and electrical equipment by Westinghouse Electric & Manufacturing Co.

To Check Pump Hum in Pipes

When pumping plants serving the water department in Pasadena were changed over from 50- to 60-cycle motors, the higher frequency seemed to set up vibrations of a new order. At any rate complaints then were made about the hum transmitted through the water system presumably from pumps which previously had not caused complaint. The usual steam-hose connection between meters and house services was not sufficient to stop these noises as it was found that the hum was transmitted through the water column itself and not through the metal of the pipes. A solution was found in a "surge chamber" put into the line in the parking strip on the service side of the meter. This has the advantage that it stops meter noises as well as the pump hum and thus makes it unnecessary to install any of the devices ordinarily used.

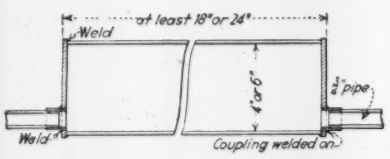


Fig. 1. Chamber for damping out pump hum and meter noises.

The surge chamber is made of a piece of 4- or 6-in. pipe not less than 18 or 24 in. long, both ends of which have been blanked off by welding on circular pieces of metal. Standard ¾- or 1-in. couplings are welded around holes in each end, set off-center, as shown in Fig. 1.

Wherever this device has been installed in Pasadena it has been effective in stopping the cause of complaint, according to Morris S. Jones, chief engineer and general manager, Pasadena Water Department.

Facts About Fluorides

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A summary of current knowledge on the distribution of fluorides in water supplies, their toxic effect, and methods of detection and removal

IN the light of present knowledge, chronic endemic dental fluorosis in the United States is a water-borne disease (1, 2) and its further production may be prevented by the simple expedient of not using water that contains fluorides (F) in excess of the permissible maximum, one part per million, for either drinking or cooking, during the period of dental susceptibility. It is well to remember, however, that the only portion of the population definitely known to need protection from the dental standpoint is the age group between birth and eight years of age, inclusive. This interval in time is sufficient to cover the period of calcification of the crowns of all the permanent teeth with the exception of the third molars.

For the purpose, therefore, of preventing the development of mottled enamel, children under nine years of age should use for both drinking and cooking:

(a) A natural water, otherwise safe, whose fluoride (F) content does not exceed one part per million, or
(b) A treated water free of toxic amounts of fluorides, or
(c) Distilled water (prepared from a water showing sufficient alkalinity), or
(d) Cistern water (free of toxic amounts of fluorides).

In the United States there are 351 known or reported endemic areas distributed among twenty-six states, and in 260 of these areas the endemicity has been confirmed by survey. The practice adopted in some states of making fluoride determination a matter of routine procedure in chemical analysis of common water supplies will no doubt largely augment this number.

The work of Smith, Lantz, and Smith (3), Churchill (4), and Velu (5) in 1931 pointed unmistakably to fluorine in the domestic water supply as the etiological factor. The causal relationship of this element to the development of mottled enamel was later confirmed by others (6), (7). The U. S. Public Health Service then carried out a quantitative epidemiological-chemical study to determine the minimal threshold of toxicity, or the maximum amount of fluorides permissible in a domestic water supply. Various aspects of this investigation, including classification of clinical diagnosis (8), which in turn permitted a quantitative estimation of the degree of affection, methodology used in determining the requisites for quantitative evaluation of fluorosis in a community (9), and several studies (10), (11), dealing with the severity of affection in communities with different concentrations of fluoride in the water supply, have been reported.

It might be well to digress here to answer a question frequently asked by residents of endemic areas, "Why do certain children have no mottled enamel while others in the same family and using the same water supply have it?" This observed difference is a purely normal manifestation of the operation of the law of normal biological variability. The effect of a poison whose concentration is somewhere between the minimal threshold and the maximal response is influenced by numerous conditions; different individuals of even a homogeneous group are not affected in precisely the same manner by the same concentration. Thus, in an examination of 289 children of 9-10-11-12 year old groups at Amarillo, Tex., in March, 1936, all of whom used continuously the municipal water for both drinking and cooking, the clinical signs of endemic dental fluorosis observed were as shown in Table I.

This frequency distribution, if depicted graphically, would roughly follow the characteristic "cocked hat" shape of a monomodal or normal curve of variation. The highest percentage is intermediate; the initial and terminal ones are the lowest.

The results of the quantitative epidemiological-chemical studies have

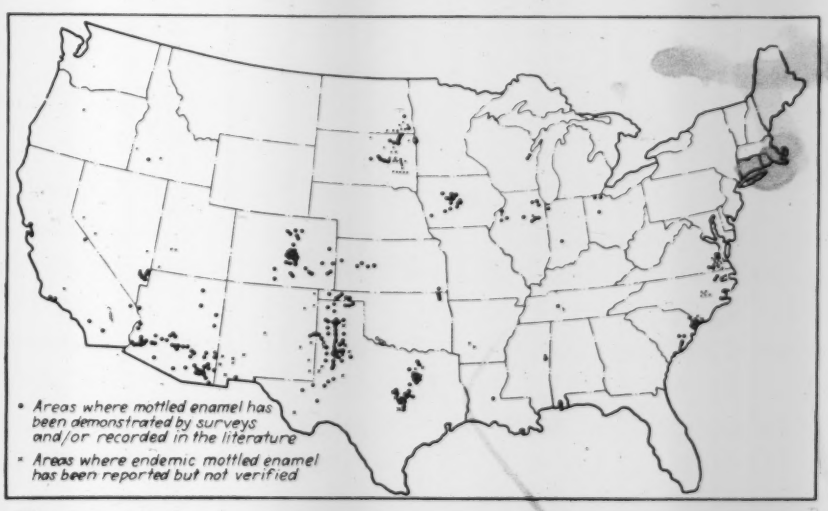
• Areas where mottled enamel has been demonstrated by surveys and/or recorded in the literature
× Areas where endemic mottled enamel has been reported but not verified

Fig. 1. Distribution of mottled enamel in the United States as of February 1938.

shown that, when the size of the clinical sample is adequate, the incidence of affection and the percentage distribution of clinical severity bear a direct relation to the fluoride concentration of the water. This definite relationship is now well established and is characteristic of chronic endemic dental fluorosis. (Table III)

Another means of depicting the quantitative relation between fluoride concentration and clinical severity may be shown by giving a definite weight to each of the several degrees of clinical affection and then computing a numerical index of clinical severity based on weighted averages for each community. To each diagnosis was given the following weight: Normal, 0; Questionable, 0.5; Very Mild, 1; Mild, 2; Moderate, 3; Moderately Severe, 4, and Severe, 5. An index of clinical severity is then computed and plotted against the arithmetic mean annual fluoride (F) content of the common water supply. A typical correlation is shown in Fig. 2.

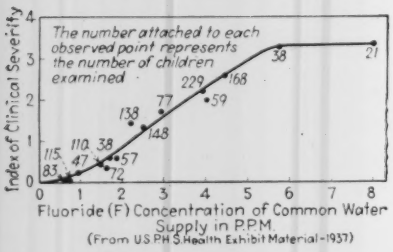
The number attached to each observed point represents the number of children examined
Index of Clinical Severity
Fluoride (F) Concentration of Common Water Supply in P.P.M.
(From U.S.P.H.S. Health Exhibit Material-1937)

Fig. 2. Relationship of clinical severity to fluoride concentration in water.

Determining fluoride content

In *Standard Methods of Water Analysis* (12) there is a description of the zirconium-alizarin method (13) for the determination of fluoride in drinking water. It is also stated that when a large number of samples of water of essentially similar characteristics are being examined, the modification of Sanchis (14) may be found useful. It is well to remember, however, that the Sanchis modification is essentially the zirconium-alizarin method excepting that in order to reduce the effect of sulfate in the sample, a comparatively high concentration of sulfate (in the form of sulfuric acid) is added to both the standards and sample, instead of balancing the sulfate effect by adding just sufficient sulfate to the standards only to equalize their sulfate concentration with that of the sample.

That the excess sulfate thus added may not compensate exactly for the effect of sulfate in the water is indicated by the results obtained by Scott and co-workers (15) who found that certain corrections are required (namely, 0.1 p.p.m. in the presence of 400 p.p.m. SO_4, 0.15 p.p.m. in the presence of 500 p.p.m. SO_4, etc.) This means that it is necessary to know the concentration of sulfate in the water even when using the Sanchis modification. But if we know the sulfate concentration of the water, it is almost as easy to correct for the sulfate by adding the corresponding quantity of sulfate to the standards and thus equalize their sulfate concentration with that of the sample. And when one has occasion to work with waters of different sulfate concentrations, one can still utilize one set of standards by applying predetermined corrections for the sulfate. Thus Table II shows the effect of varying sulfate concentrations in the presence of 1.5 p.p.m. of fluoride (F).

According to Scott and co-workers, 0.1 mgm. (F.) in 100 c.c. is about the limiting amount for a good color distinction when using the Sanchis

TABLE I. FREQUENCY DISTRIBUTION OF MOTTLED ENAMEL IN AMARILLO, TEX.

	Normal	Questionable	Very Mild	Mild	Moderate	Moderately Severe	Severe
Number	9	19	44	81	98	32	6
Per Cent	3.1	6.6	15.2	28.0	33.9	11.1	2.1

TABLE II. EFFECT OF SULFATE ON THE FLUORIDE DETERMINATION BY THE ZIRCONIUM-ALIZARIN METHOD

Sulphate (SO_4) Concentration	True Fluoride (F) Concentration	Apparent Fluoride (F) Concentration	Approximate Fluoride (F) Equivalent of the Sulfate (SO_4)
10 p.p.m.	1.5 p.p.m.	1.6 p.p.m.	0.1 p.p.m.
50	1.5	1.6	0.1
100	1.5	1.7	0.2
200	1.5	1.8	0.3
500	1.5	1.9	0.4
1000	1.5	2.0	0.5

TABLE III. QUANTITATIVE RELATION BETWEEN FLUORIDE (F) CONCENTRATION IN THE COMMON WATER SUPPLY AND THE SEVERITY OF CLINICAL AFFECTION

City and State				Pueblo, Colo.	Junction City, Kans.	Mullins, S. C.	East Moline, Ill.	Webster City, Iowa	Monmouth, Ill.	Galesburg, Ill.	Clovis, N. M.	Colorado Springs, Colo.	Plainview, Texas.	Amarillo, Texas.	Conway, S. C.	Lubbock, Tex.	Post, Tex.	Ankeny, Iowa.
Mean Annual Fluoride (F) Content in p.p.m.				0.6	0.7	0.9	1.5†	1.6	1.7	1.8	2.2	2.5	2.9	3.9	4.0	4.4	5.7	8.0‡
Number of Children Examined				83	115	47	110	72	38	57	179	148	97	289	59	189	38	21
Percentage Incidence of Affection				2.4	1.7	10.6	24.5	26.4	42.1	35.1	72.1	67.6	87.6	90.3	88.2	97.8	100	100
Percentage Distribution of Clinical Severity	Pathognomonic Signs	Absent	Normal	88.0	95.7	68.1	55.5	65.3	36.8	45.6	11.7	18.2	4.1	3.1	5.1	1.1	——	——
			Questionable	9.6	2.6	21.3	20.0	8.3	21.0	19.3	16.2	14.2	8.3	6.6	6.7	1.1	——	——
		Present	Very Mild	2.4	1.7	8.5	18.2	22.2	36.8	26.3	21.8	28.4	34.0	15.2	20.4	12.2	——	——
			Mild	——	——	2.1	5.4	4.2	5.3	5.3	36.9	21.6	26.8	28.0	32.2	21.7	10.5	9.5
			Moderate	——	——	——	0.9	——	——	3.5	12.3	14.2	23.7	33.9	23.7	46.0	50.0	47.6
			Moderately Severe	——	——	——	——	——	——	——	1.1	3.4	3.1	11.1	11.9	15.3	34.2	33.3
			Severe	——	——	——	——	——	——	——	——	——	——	2.1	——	2.6	5.3	9.5
Age Group or School Group Examined				9	9–10 11	9–10 11	9–10 11	9–10 11	9	9	9–10 11–12	9	9–10 11–12	9–10 11–12	9–10 11	9–10 11–12	4–5 6 grades	2–12 grades

†Subject to possible correction to 1.3 p.p.m.
‡Based upon a single chemical determination; all others represent arithmetic mean annual fluoride (F) content.
(From Public Health Reports, *53*: 1249–1264, Sept. 10, 1937).

modification. This corresponds to 1 p.p.m. In other words, by the Sanchis modification, 1 p.p.m. appears to be about the limiting concentration of fluoride for a good color distinction. But one part per million of fluoride (F) is also the permissible limit for a drinking water. That is, it is the concentration for which a reliable determination is particularly important because on that determination will depend the conclusion to be reached whether or not the water may be used. Sanchis adds 2 c.c. of 3 N sulfuric acid to 100 c.c. of the water. This corresponds to about 2,880 p.p.m. of sulfate (SO_4).

When sulfate was added to distilled water known to be free of fluoride, in an amount corresponding to only 1,000 p.p.m., the zirconium-alizarin reagent reacted as if the water contained about 0.8 p.p.m. of fluoride (the sulfate apparently affecting the reagent more than in the presence of fluoride, the effect of the sulfate decreasing with increasing fluoride concentration). It appears, therefore, that when dealing with the smaller fluoride concentrations, it is an advantage not to introduce any more sulfate than is necessary to balance the concentration of sulfate in the water. In other words, the less sulfate added, the more direct is the fluoride determination.

Removal from water supplies

Practical methods for the removal of fluoride from drinking water are still in the experimental stage. Our own efforts are at present directed to the development of the Magnesium oxide method (20). Additional data on methods of removal are given in the accompanying references (15–23).

In experiments with a water containing 5 p.p.m. of fluoride (F), using a finely-divided calcined magnesite of the type used in the construction of cement floors, the fluoride content of the water was reduced to within the permissible limit of 1 p.p.m. The treatment with the magnesium oxide was carried out in two stages. If we do not consider the residual fluoride-removing power of the used magnesium oxide (which probably could be utilized) and limit our calculations to the quantities of water in which the fluoride was reduced from 5 p.p.m. to 1 p.p.m. or less in not exceeding two treatments, the results obtained indicated that one pound of the magnesium oxide could serve to treat about 88 gallons of such water.

Since calcined magnesite is used extensively in building operations and large quantities of magnesium compounds are in demand for various purposes, it is quite probable that it will be possible to reduce the cost of treatment considerably through the utilization of the used magnesium oxide.

In this connection, it is interesting to note that in a recent review of lime-soda softening, C. P. Hoover (24) calls attention to the fact that disposal of lime sludge is one of the major problems in lime-soda ash municipal softening. He suggests that the problem could be solved by applying what he terms "a two-way application of lime" so as to obtain a lime sludge containing practically no magnesium. This would permit the utilization of the lime sludge for producing the lime needed in the water softening. The magnesium remaining in the water could then be precipitated separately. It may be pointed out, therefore, that such a procedure at lime-soda water softening plants could, with but few modifications, be made to serve advantageously not only in solving the sludge problem but also for providing a cheap source of magnesium oxide for fluoride removal, within the water works industry itself. In other words, municipalities with magnesium-containing waters and municipalities having the problem of fluoride removal could cooperate to mutual advantage.

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Water Facilities Expanded In The South

DEVELOPMENT of water facilities in the South to meet the growing demands for expanding population and steadily rising standards of living, as well as to provide for the increased needs of the South's industries, made great strides in 1937, according to a recent survey made by the American Water Works Association.

In the seven states of Alabama, Arkansas, Georgia, Louisiana, Mississippi, Tennessee and Texas, 95 waterworks systems were constructed or their facilities extended last year, the association found. At the beginning of 1938, a total of 73 additional projects were either underway or planned for the current year in the seven states. Similar progress is being made in the other Southern states, although the individual projects in them have not as yet been tabulated.

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Winnipeg Taxes Its Water Consumers

WINNIPEG, MAN., has approved a new tax to charge water consumers for operation and maintenance costs of sewage disposal facilities, according to *The Canadian Engineer*. A tax of ten cents quarterly for each room in a house has been made effective. Consumers other than residential will be charged according to water consumption at a rate of seven cents per 1,000 gal.

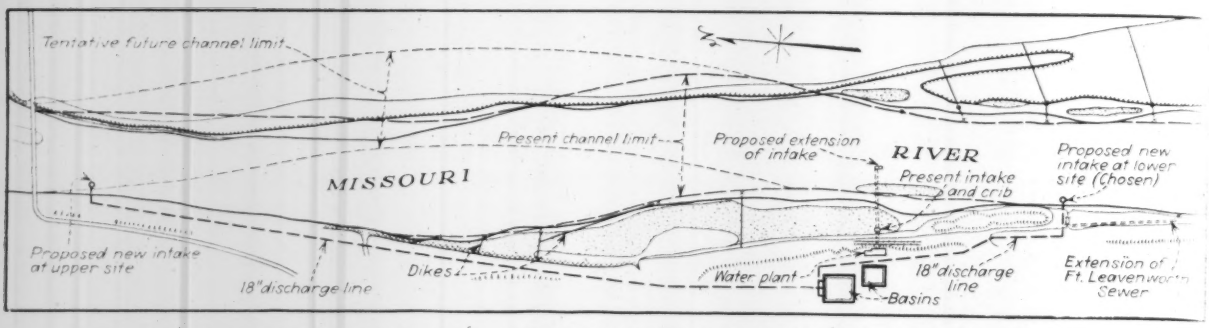

FIG. 1. INTAKE LOCATION STUDIES MADE AT LEAVENWORTH TO AVOID SANDBAR FORMATIONS

Revamping a Water System

R. E. LAWRENCE

Assistant Engineer with Black & Veatch, Consulting Engineers, Kansas City, Mo.

Problems of management and financing were tackled first in putting the run-down Leavenworth water utility in shape for good service

A COMPREHENSIVE PROGRAM of improvements now under way for the rehabilitation of the run-down Leavenworth, Kan., waterworks system presents a number of unusual engineering and economic problems. Aside from replacement of the original steam boilers and part of the pumping equipment no improvements of any consequence have been added since the plant was first constructed in the period from 1882 to 1887.

The drop in revenue due to losing Fort Leavenworth and the federal prison as customers, the possibility of losing other large institutional users, the fact that bonds were maturing without funds available for payment, a constantly increasing operating cost due to obsolete and run-down equipment and the shutting off of the water supply by a federal river improvement program, presented some knotty problems in administration, engineering and finance.

The immediate construction program consists of the installation of a new intake and low-service pumping station, a modern filtration plant and high-service pumping station and the flooring and covering of the present 5-m.g. high-level reservoir, together with the installation of connecting pipe lines.

Situated on the Missouri River, Leavenworth, now a city of 17,500 population, was founded shortly after the establishment of Fort Leavenworth. In addition to the fort, the federal prison, the federal Soldiers Home and the U. S. Veterans Hospital are located here. The city is also a center for furniture and allied manufacturing.

The city has owned and operated its water utility since 1921, at which time the system was purchased from a private company. The plant includes a crib intake in the Missouri River, boiler and pump room, settling basins, distribution system and an elevated storage reservoir.

Water not filtered

Leavenworth is one of the few cities still using unfiltered surface water. It depends on settling only for purification. Raw water turbidities of 20,000 p.p.m. and more are not at all uncommon and during periods of adverse river conditions the quality of the finished water is far from satisfactory.

In undertaking the present improvement program it was necessary for the city to overcome a number of what appeared to be almost insurmountable obstacles. For many years the federal institutions have been the city's largest consumers and the source of a substantial portion of the revenue. The inability to provide for filtration, however, caused the War Department in 1935 to construct a separate supply at Fort Leavenworth consisting of wells and an iron-removal and softening plant. Water service to Fort Leavenworth was discontinued in March, 1935, and when the Fort supply was made available to the federal prison in 1936 this institution discontinued taking water from the city.

The seriousness of the situation resulted in the city obtaining passage of a statute authorizing the formation of a water works board, which would have complete charge of the utility. This plan of management was adopted by the people at a general election and board members were elected at a subsequent referendum. The board, which took office in August, 1937, is made up of leading business men and is headed by a consulting engineer for a nationally known contracting firm, as chairman. Its first action was the initiation of engineering studies involving all features of the physical property and the associated matter of operating costs.

With these surveys underway the difficult problem of finance was tackled. Bonds were maturing in a

few months and funds were insufficient to meet the payments. At the same time it was necessary to begin extensive improvements in order first to assure an adequate supply, and second, to enable the system to furnish a pure and wholesome water economically. The problem was especially difficult due to the fact that the peak of the debt service requirements of the bonds, issued to acquire the system in 1921, occurs over the next four or five years. It was quite clear that capital expenditures at this time would have to be kept at an absolute minimum. The board desired that all new work be done on a permanent and sound basis, however, and the program of construction and financing was worked out to conform to these requirements.

An attractive rate for electric pumping has been made available by the company serving the city, which makes electrification of both low and high-service pumping the most economical plan. The estimated savings in yearly operating costs will take care of the debt service due to lower pumping, labor and maintenance costs brought about by the present improvement program.

The financial program involves the issuance of sufficient revenue bonds to retire the bonds on old indebtedness that were due the first of this year and to cover the cost of the present improvement program, estimated at $290,000. These revenue bonds are of the serial type and were issued at 3½ per cent interest, with maturities such that the peak of debt service on old indebtedness will have passed before heavy obligations occur on the new.

Intake works studied

The present intake works consist of a tunnel driven through rock from the low-service pump pit to a wood pile crib near the bank of the river. A cast-iron suction line is located in the tunnel terminating at the crib in a swivel joint and a length of steel pipe, which is raised and lowered by hoist supported on top of the crib. A screen is placed over the end of the line for the protection of the pumps.

During the past few years the U. S. Corps of Engineers has been engaged in an extensive program of channel stabilization to make the Missouri River navigable above Kansas City. Training dikes recently constructed a short distance upstream from the intake have caused a shifting of the current leaving the intake in shallow water at a point of bluff behind a rapidly forming sand bar. Extensive dredging operations have been required during the past two seasons to keep the intake open. The effect of the training dikes constructed upstream and the bar which is forming in front of the intake as shown in Fig. 1.

Fig. 2. Present river intake which is to be replaced immediately.

To insure an adequate water supply it is necessary that a new intake be constructed in the permanent channel of the river. Consideration was first given to the possibility of extending the present intake line and the construction of a new intake in the new channel. This plan would require a comparatively small initial expenditure but it is open to a number of rather serious objections. The channel at this point is still more or less in the formative stage and it may be several years before complete stabilization is accomplished. There is the possibility that further shifting of the channel may occur in which event the city might be compelled again, at a later date to relocate the intake in deep water. The training dikes located upstream have resulted in the formation of the bar over which the intake line would be extended. Eventually this bar will probably be built up and become consolidated. However, should the dikes become damaged so that they no longer afforded protection the intake line would be subject to destruction by floods or ice.

Careful studies, involving several alternate designs, made it evident that it was unwise to attempt the construction of a permanent intake structure and low-service pumping station at the site of the present structures, and that a new location should be found where bluff contact with the main river channel could be assured at all times. One site is available 6,000 ft. upstream from the present intake and another 1,700 ft. downstream. The downstream location is much nearer the plant and is at a point where deep water will be maintained by the government for the possible use of barges and for maintenance of a channel under a railroad bridge downstream. However, this site is only 300 ft. above the outlet of two sanitary sewers, one a combined storm and sanitary sewer from the city and the other a 24-in. sewer from the Fort. This situation is being overcome by the construction of an intercepting sewer which will collect and discharge the sewage 1,300 ft. below the intake location. There is sufficient current in the river at all periods of the year to eliminate any possibility of pollution reaching the intake from this source.

The new structure is a combined intake and low-service pumping station. Water will be admitted through intake ports protected by coarse racks. Screening will be accomplished by revolving mechanical screens and pumping will be by motor-driven centrifugal units. About 2,600 ft. of 18-in. discharge line will be constructed to deliver the water to the present settling basins.

Filtration plant details

Present maximum consumption is slightly more than 3 m.g.d. and a filter plant having a capacity of 4 m.g.d. is considered adequate for the city's requirements for a reasonable period in the future due to the large storage provided by the 5-m.g. high-level reservoir. In designing the filter plant no changes are being made in the present settling and coagulating basins and the only additions will be a secondary mixing chamber and small reaction basin.

Provision is made in the design of the filter plant so that complete softening may be added at a later date when finances permit. When this is done alterations will be made

in the basin arrangement and mechanical clarifiers will be utilized for the removal of sludge which is now accomplished by draining and cleaning the basins. When these basin improvements are completed it will be possible to abandon one basin now used for plain settling and to reduce the operating head through the plan by some 20 ft.

At the present time coagulant is added following plain settling and the coagulated water allowed to settle. No change will be made in the method of applying coagulant or in the point of application. However, provision is made in the new plant for the installation at a later date of chemical handling equipment.

High-service motor-driven centrifugal pumps are to be located at the new plant. They will operate at a head of 350 ft. The city is fortunate in having available an elevated storage reservoir with a capacity equal to three times the present average daily consumption. The reservoir, 216 ft. in diameter and 20 ft. deep, is uncovered. The circular walls are of masonry, but the reservoir has no floor and much water is lost by seepage. The elevation of the reservoir is such that the pressure on a major portion of the distribution system is from 120 to 150 lb. This is somewhat higher than that of the average distribution system but is required to furnish service to some of the federal institutions.

It is planned to divide the city into two pressure zones with intermediate storage as soon as funds can be made available. The existing pressures in the lower areas, which includes the business section, are too high. They require special plumbing and cause excessive leakage. In addition to providing ample capacity for consumer demand and satisfying underwriters' requirements the large reservoir permits a more or less uniform operation of the plan, from day to day.

To eliminate loss by seepage and to protect the filtered water from "after contamination" it is considered essential to provide the reservior with a concrete floor and cover, which work is included in the present improvement program.

The main feature of the proposed improvements at Leavenworth of interest to water works officials is the manner in which the board took hold of what appeared to be a hopeless situation, and worked out a program along lines that would be followed in any private enterprise under efficient and intelligent management. Essentials such as the water supply itself, its purification and proper storage, are being taken care of now, and other desirable features, not absolutely needed to furnish an adequate supply of pure water, have been deferred until financial condition of the property will warrant additional expenditure. Rates could have been raised but the present schedule is comparatively high. Probably a raise would have resulted in loss of revenue rather than an increase. The system, though much run down, due perhaps to indifference on the part of the citizens as well as to indifferent management, is basically capable of sustaining itself. The board has selected a program which will enable the plant to be self maintaining, and one which over a period of years will give the city a well-balanced system.

Soon after taking office the board secured the services of an experienced and competent superintendent. One of the first things undertaken by him was the establishment of a routine system of meter testing and checking, as it was found that a considerable amount of revenue was being lost due to the condition of meters. Many other similar operating features are being placed upon proper standards.

The Leavenworth Water Works Board consists of E. H. Connor, chairman; H. B. Goodjohn, secretary; W. H. Read, manager accounts and collections; Carl Krekeler, E. Mezzera and W. G. Leavel, board members. E. H. Kansteiner is manager of production and distribution. Black & Veatch, Kansas City, Mo., are the consulting engineers.

Water Supply and Drainage In New Orleans

SITUATED near the mouth of the mighty Mississippi, New Orleans has a limitless quantity of water upon which to draw for its supply. The elevation of the city is below high water in the river, however, and this complicates the problem of removing waste water and storm runoff, all of which must be pumped. Construction and operation of facilities for both the supply and disposal of water are carried out by a sewerage and water board, of which Alfred F. Theard is general superintendent.

The board has advanced the construction of water and sanitary improvements since its formation in 1899, and at the present time the city has 800 miles of water mains, 700 miles of sewers (serving about 96 per cent of the city), and about 950 miles of drainage canals and pipelines which cover the entire area within levees, some 50,000 acres. The population of the city is 516,000.

The water supply drawn from the river is muddy, but it shows little evidence of the pollution which has drained into it throughout its long line of travel. The raw water is pumped to the purification plant where it is first settled and then dosed with lime and sulphate of iron. After being thoroughly mixed with the chemicals, the water passes into coagulation basins. From here it is drawn into a filter of the rapid gravity sand type with a capacity of 112 m.g.d. The water is then chlorinated and pumped continuously into the distribution system. Continuous and direct pumping must be used because there are no possible elevated reservoir sites in the flat-lying terrain.

Because of occasional excessive rainfall and due to its location below high water in the river, the city has been provided with a canal system and nine large drainage pumping stations for the removal of stormwater. All the water must be pumped and some of it is pumped two or more times before it is finally discharged into the tide-level outfall. Some of these canals are wood lined, some are lined with masonry and others are built of reinforced concrete. The largest are 25 ft. or more in width and, when running full, have 9 ft. or more depth of water.

Entirely separate from the drainage system are the sanitary sewers. These range in size from 8 in. to 7 ft. in diameter. All the sewage must be pumped and for this purpose there are 12 intermediate stations and four final stations which discharge the sewage into the river downstream from the city. All the stations are electrically driven.

THE WEEK'S EVENTS

Continued from page 561

Lane Named Consultant To Housing Authority

Charles E. Lane has been appointed special consultant to the U. S. Housing Authority by administrator Straus. Lane is a member of the New York building firm of Barr & Lane, Inc., which built a number of the units in the Rockefeller Center in New York City.

Lane served with the Chinese government from 1913 to 1921 on the construction of school buildings in connection with the program financed by the Boxer indemnity fund. When he returned to the United States, he became associated with Todd, Robertson & Todd, managers of the Rockefeller interests, and formed his present partnership in 1927. Lane is a graduate of Polytechnic Institute of Baltimore and has practiced as an architect in Baltimore.

Housing Authority funds have been earmarked for 13 additional cities. The new earmarkings amount to $70,920,000 and raise to $225,466,000 the amount already earmarked for 67 communities. Of the new earmarkings, $59,100,000 constitute additional funds set aside for six large cities which have already received substantial earmarkings. These cities, and the total amounts now available for them, are: New York, $30,000,000; Detroit, $25,000,000; Philadelphia, $22,000,000; Cleveland, $18,000,000; Baltimore, $15,000,000; Pittsburgh, $13,500,000.

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FPC to Estimate Cost Of Electric System

The Federal Power Commission will make a preliminary estimate of cost for a proposed electric distribution system for the city of Fort Worth, Texas, and a forecast of the power requirements of that city during the next decade. FPC is acting at the request of city officials and of the Lower Colorado River Authority, which has been negotiating with the city for the sale of power. Expenses of the investigation will be borne by the city.

The proposed survey has no connection with existing privately-owned facilities in the city, but will simply provide an engineering estimate of the cost of constructing a new distribution system capable of serving the city for some years in the future.

Fort Worth has been negotiating with the Lower Colorado River Authority for the purchase of power from Buchanan Dam, about 175 miles from the city. The authority, a state agency, is building four dams on the Colorado River in Texas, all of which will produce hydro-electric power.

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New York Power Authority Allowed to Intervene

The Power Authority of the State of New York has been given permission to intervene in proceedings now before the Federal Power Commission on an application of the Niagara Falls Power Co. for permission to divert an additional 275 sec.-ft. from the Niagara River. Intervention was opposed by the company and by the Water Power and Control Commission of the State of New York (*ENR*, March 24, 1938, p. 431).

Although it has been objected that the power authority lacks authority to represent the state in this matter, FPC asserted that the authority was a "duly qualified agency of the state of New York" and is "charged with duties . . . directly relating to the development of navigation and the creation . . . of hydroelectric power . . . in the St. Lawrence River." The authority, it was held, "is a potential competitor of the applicant in the pending procedure."

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Memphis and Massachusetts Win in Safety Contest

National grand prize for cities was awarded to Memphis and for states to Massachusetts in the sixth annual national traffic safety contest conducted by the National Safety Council. First prizes in their population groups went to Milwaukee, Hartford, Everett, Wash., Des Plaines, Ill.; Beaumont, Texas, and Sacramento, Calif., tied for first place in their groups. Winning states by regions were Oklahoma, North Dakota, Nevada.

The national grand prize for cities, which was awarded last year to New York City, goes to the city which comes nearest to doing the maximum safety work practicable in that particular city. In the scoring, 50 points were allowed for low death rate and reduction of death rate below the average for the three previous years; 5 points for completeness in accident reporting and maintenance of a permanent accident record file; 15 points for traffic law enforcement; and 10 points each for safe traffic planning, development of child safety programs and public safety education programs.

SEDIMENT MEASUREMENT LABORATORY

NEW TYPE of laboratory for sediment load tests has been completed by the WPA for the Soil Conservation Service at Rocky Creek in Iredell County, N. C.

Fourteen concrete veins are spaced 5 ft. apart between concrete and stone revetments on the banks. Four feet below each section is a 15 in. pipe leading to the pump house. Hydraulic oil cylinders permit a sample from any vein to be pumped into vats, where qualitative and quantitative analysis of the sample determines from the suspended load what bed load of sediment is carried by the stream.

CALENDAR OF MEETINGS

NATIONAL SOCIETIES

AMERICAN SOCIETY OF CIVIL ENGINEERS, Spring meeting, Jacksonville, Fla., April 20-23.

AMERICAN SHORE & BEACH PRESERVATION ASSOCIATION annual meeting, Washington, D. C., April 19, and Jacksonville, Fla., April 21.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Roosevelt Hotel, New Orleans, April 24-28.

WATER WORKS MANUFACTURERS ASSOCIATION, annual meeting, Roosevelt Hotel, New Orleans, April 27.

CONCRETE REINFORCING STEEL INSTITUTE, annual meeting, The Homestead, Hot Springs, Va., April 28-29.

NATIONAL LIME ASSOCIATION, annual convention, Netherland-Plaza Hotel, Cincinnati, May 9-10.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Chalfonte-Haddon Hall, Atlantic City, June 27-July 1.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, annual meeting, Texas A. & M. College, College Station, Texas, June 27–30.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, summer convention, Washington, D. C., June 20–24.

REGIONAL AND LOCAL

GREATER NEW YORK SAFETY COUNCIL, annual convention, Hotel Astor, New York City, April 19-21.

AMERICAN WELDING SOCIETY, Pittsburgh section, and ENGINEERS SOCIETY OF WESTERN PENNSYLVANIA, tri-state welding conference, William Penn Hotel, Pittsburgh, April 29.

AMERICAN SOCIETY OF CIVIL ENGINEERS, Texas Section, spring meeting, Texas State Hotel, Houston, April 29-30.

MARYLAND-DELAWARE WATER AND SEWERAGE ASSOCIATION, annual conference, Emerson Hotel, Baltimore, May 19-20.

SECTION MEETINGS, American Water Works Association:
Pacific Northwest, Spokane, May 19-21.

ELECTIONS AND ACTIVITIES

W. R. CHEDSEY was elected president of the Missouri State Society for the Promotion of Engineering Education at its seventh annual meeting. J. R. Lorah is vice-president and Eugene Stephens, secretary. The 1939 meeting will be held in St. Louis.

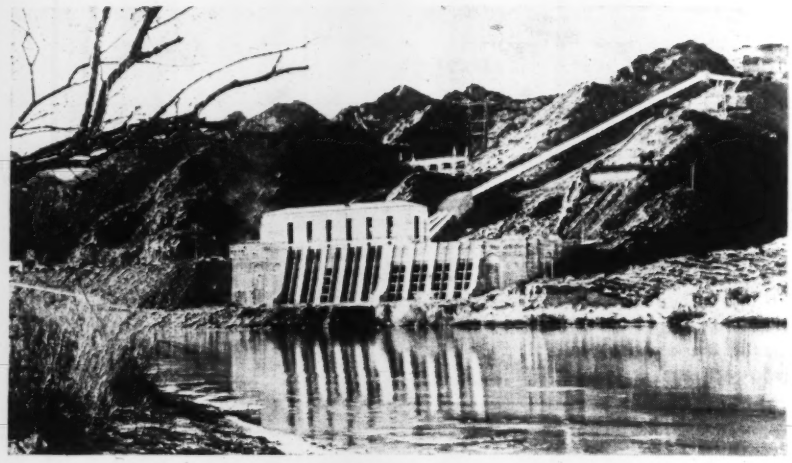
THE ASSOCIATED WISCONSIN CONTRACTORS have affiliated with the American Road Builders Association. The president of the Wisconsin group is Roger Van Vetchen; L. G. Arnold is vice-president, N. M. Isabella, secretary, and A. J. Koch, treasurer. The association has offices in Milwaukee.

AN ARKANSAS CHAPTER of the National Society of Professional Engineers was organized recently at Little Rock. Temporary president is Leonard N. White; Kenneth W. LeFever is temporary secretary-treasurer, and Fred J. Herring is national director.

NEWLY ELECTED officers of the Kentucky-Tennessee section of the American Water Works Association are C. M. McCord, chairman; Hall Arnold, vice-chairman; E. E. Jacobson, director, A.W.W.A.; Howard D. Schmidt, secretary-treasurer. L. S. Vance, chief engineer of the Louisville Water Co., was given the George W. Fuller Award for his resourcefulness in connecting pumps at the River Road pumping station to a steamboat after the 1937 flood had drowned out the station's own steam plant. The section will discontinue publication of papers and substitute a monthly news bulletin.

OPTIONAL certification of competency for waterworks operators has been started in Illinois by voluntary action, it was brought out at the annual meeting of the Illinois section of the American Water Works Association. The plan is being carried out by the State Board of Health with the assistance of an advisory committee. Certificates are to be issued to three classes of operators. The certificate program has no legal significance but is an indication of the operators' ability and qualifications to operate a treatment plant. New officers are as follows: W. D. Gerber, chairman; F. G. Gordon, vice chairman; C. W. Klassen, State Board of Health, Springfield, secretary-treasurer. C. M. Roos was chosen to receive the George W. Fuller award at the New Orleans convention.

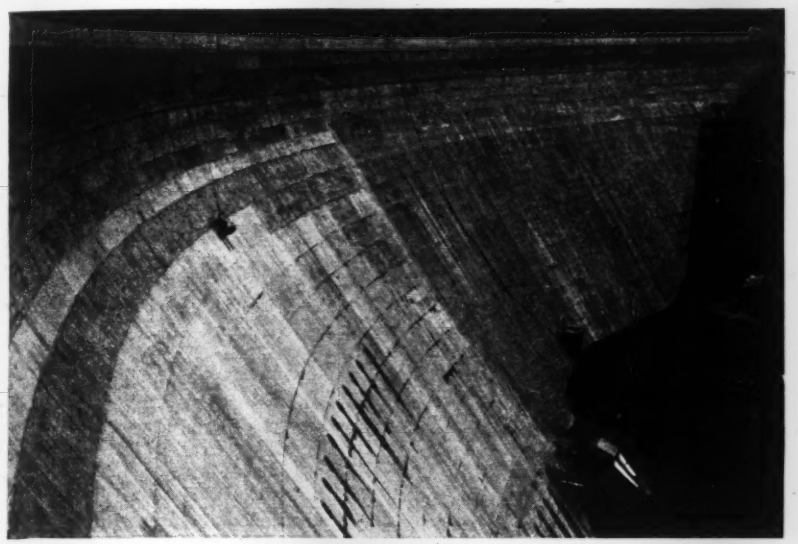
CERTIFICATION of operators is also being considered in Indiana. B. A. Poole, chief engineer, State Board of Health, commented favorably on the movement at the meeting of the Indiana section of the A.W.W.A. but questioned whether the board could legally require registration. W. C. Mabee, chief engineer of the Indianapolis Water Co., was selected to receive the George W. Fuller award. Newly elected officers are as follows: Paul C. Laux, chairman; M. H. Schwartz, vice chairman; J. A. Bruhn, Indianapolis, secretary-treasurer; W. A. Oeffler, assistant secretary-treasurer. The section received the Nicholas S. Hill, Jr., cup for having made the largest percentage gain in membership during the year and also received the Franklin Henshaw cup for holding the best attended meeting during the year.



PARKER RESERVOIR TO BE FLOODED SOON

WATER will be backed up behind the Parker Dam on the Colorado River during April. All five of the 50x50 ft. slide gates were installed in the dam by March 15. Work on the buildings for the Intake pumping plant of the Colorado River aqueduct, two miles upstream from Parker Dam, was 98 per cent complete at that time.

Located on the California bank of the Colorado River, the Intake plant is the beginning of the 392-mi. aqueduct being built by the Metropolitan Water District of Southern California. It is one of five plants which will lift aqueduct water a total height of 1,616 ft. between the river and southern California's coastal plain.



NEW FACE FOR ARROWROCK DAM

REFACING Arrowrock Dam has been completed by the Bureau of Reclamation. A slab of concrete has been placed on the lower face, where the original concrete made of sand and cement had deteriorated. The remainder of the structure has been covered with a coat of shotcrete. The project also included raising the height about 5 ft.

Arrowrock Dam is the major structure in the Boise federal reclamation project in Idaho. When it was originally built, the dam, 354 ft. high, was the tallest in the world.

Public Forums Are Planned By Engineering Council

In an attempt to widen appreciation of the engineering viewpoint on public questions, the executive committee of the American Engineering Council proposes to initiate a series of public forums to be held during 1938 in cooperation with local engineering groups. Arrangements are under way for the first forum, to be held in Philadelphia.

This new activity was announced in connection with a program for the coming year for the A.E.C. This program holds that the major functions of the council fall under three main classifications. The public affairs function is held to embrace the presentation of the engineer's viewpoint on public affairs; this includes presentation of engineering opinion and facts to the federal government and interpretation for the engineering profession of federal activities. Public discussion, of which the proposed forums are the chief example, is held to be a second major function; and it is held that the council should continue to function as an "embassy" in Washington for the engineering societies.

In addition, publicity and fact finding will be given as much attention as the forces available to the council permit. In this connection the bulletin of the A.E.C. is to be expanded to include more interpretative material on events in Washington. Proposed fact finding investigations to be carried out, if possible, include a survey of employment, unionization and registration of engineers and an attempt to determine the effects of technology on employment.

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Large Profit Realized From PWA Bond Sales

Profit to the government arising from the sale of municipal PWA bonds to the public through the Reconstruction Finance Corp. amounted to $12,859,000 at the end of March. Interest on PWA bonds to the end of March totaled $22,540,000. States and municipalities and other public bodies which borrowed from PWA paid 4 per cent interest, while the federal government paid an average of 2⅜ per cent on its borrowings.

PWA has sold $601,818,000 worth of securities to RFC, most of them municipal bonds posted as collateral for PWA loans. RFC, acting as agent for PWA, has sold $431,331,000 worth of these bonds to the public. PWA still holds in its portfolio $47,927,000 of securities of public bodies which it has not yet turned over to the Reconstruction Finance Corp. for sale.

BRIEF NEWS

THE MCCALLIE AVENUE TUNNEL in Chattanooga, roof of which collapsed last month, is to be repaired by th Tennessee State Highway Department with its own forces. The cost is estimated at about $100,000.

CONSTRUCTION of sidewalks for pedestrian traffic for state highways near cities and towns is provided for in a bill signed by Governor Price of Virginia.

A COURSE dealing with the legal and social phases of engineering is to be offered next year at Johns Hopkins School of Engineering. The course will be taught by Abel Wolman, professor of sanitary engineering.

A CONCRETE roadway is to be placed on the lower deck of the Manhattan bridge across the East River of New York City replacing the present wood block floor. Cost of the work is estimated at $750,000.

ROOSEVELT signed a bill on April 2 authorizing the states of North Dakota, South Dakota and Minnesota to enter into an interstate compact for flood control and pollution abatement on interstate streams.

INVITATIONS have been issued by the United States to all foreign governments to send delegates to the International Congress of Architects to be held in this country in 1939. Chairman of the American delegation is Charles D. Maginnis, president of the American Institute of Architects.

AN INSUFFICIENCY of combustibles in Detroit garbage is raising the cost of operation of the city's new incinerator plant, according to public works commissioner Beyster. At present 50 tons of coal is being used every day at the two incinerators.

THE BRAZOS River Conservation and Reclamation District has filed an application with the Federal Power Commission for a license for the proposed Possum Kingdom project, on which a contract has just been awarded. The district plans to construct a flood control system of thirteen dams in the Brazos district, developing power at four or five of them.

THERMAL insulating materials will be studied by a new standing committee, C-16, set up by the American Society for Testing Materials. The new committee will undertake work on insulations for use at somewhat lower temperatures than those which have been studied by

Committee C-8 on refractories. Housing insulations will not be considered for the present.

GLASS BLOCKS or glass bricks may be used in St. Louis as part of building walls under the terms of an ordinance passed by the Board of Aldermen April 1.

COLORED PAVEMENT was rejected by the Seattle city council when it was advised by the city engineer that coloring matter would increase the cost 32 to 60 cents a square yard.

PARKING within a hundred feet of traffic light controlled intersections or within 20 ft. of the building line at uncontrolled intersections has been forbidden in the city of Washington, D. C.

A REFRIGERATOR BARGE equipped to transport fruits and vegetables on inland waterway systems is being completed by the Tennessee Valley Authority. No motive power is included, and the barge will be towed. The experimental unit is being jointly operated by TVA and the University of Tennessee; if results are satisfactory, a number of additional units will be built.

TWO IRRIGATION RESERVOIRS, at Unity Dam on the Burnt River in Oregon and at the Caballo Dam on the Rio Grande in New Mexico, were put into service last month. Unity Dam is finished, and Caballo Dam is 75 per cent completed; it can safely be used because the river is controlled by Elephant Butte Dam.

AN INVESTIGATION of the claim of Lars Jorgensen of Oakland, Calif., that the city of Seattle copied his plan for a constant angle arch dam in building Ruby Dam, has been ordered by the city board of public works.

THE RIGHT of a municipality to prohibit the erection of wooden buildings under a state zoning law will be passed upon by the Texas Supreme Court in a pending action. The court has agreed to review a decision of the Galveston Court of Appeals which upheld an injunction granted by a district court preventing the city of West University Place from interfering with construction of a wooden building. The action was originally instituted against the city by J. Henry Martin and others.

A PLAN to transform the unpleasant areas around New York City's incinerator plants into parks and recreational spots has been announced by the WPA there. WPA expects to spend about $831,000 on this work in Brooklyn, the Bronx, Queens and Staten Island.

PERSONAL

DRACO DODRILL has been appointed city engineer of Parkersburg, W. Va., succeeding Thomas S. Lang.

G. G. HARE, city engineer for the past 20 years of the city of St. John, N. B., and in recent years also building inspector for the city, has retired. His duties will be taken over by D. R. Smith, recently appointed director of works for St. John.

VINCENT J. SCANLAN, executive engineer of District No. 1 of the New Jersey WPA, has been made city engineer of Patterson, N. J. Scanlan has served on the Patterson city planning engineering board for two years and was at one time assistant engineer of the city.

ROSS CALDWELL has been appointed architectural engineer of the Illinois department of public works and building. Caldwell was formerly district architect in the National Park Service. He has been associated with the firm of Caldwell & Drake and has practiced privately.

CAPT. BENJAMIN F. CHADWICK, who has been assigned to the Pittsburgh district of the U. S. Engineers, is to be attached to the staff of the district engineer at Galveston.

JOHN V. ZAHLEN, who has been taking graduate studies in Switzerland for the past six years, is returning to the United States. Zahlen was for a number of years engaged on structural work in Chicago and on water power development on the Pacific Coast, and has also done work in South America and Scandanavia.

P. J. WATSON, JR., has been elected president of the Terminal Railroad Association of St. Louis. He has been president of the Kansas City Terminal since 1932.

ALAND A. C. KRAMS has been appointed chief architect of the Connecticut state public works department as the result of civil service examinations. He replaces Frederick C. Teich, the incumbent, who failed to qualify in the examination.

BRIG. GEN. RICHARD C. MOORE, who was promoted to the rank of Brigadier General March 1, has been transferred from Fort Logan, Colo. to the Panama Canal zone to take command of the Atlantic sector.

CARLTON C. MASSEY, city engineer of Fredericksburg, Va., on April 1 became town manager of Salem, Va.

H. G. RICHEY retired on March 1 from the position of district engineer for the public building branch of the U. S. Treasury Department. He has been in charge of public building construction in the eight Southeastern states. Richey, who has reached the retirement age, has been with the public building branch and its predecessor, the supervising architect's office, for 36 years.

DUDLEY T. CORNING, chief of the Bureau of Highways of the Philadelphia department of public works and who for the past year has also been acting chief of the Bureau of Street Cleaning, has been appointed chief of the newly created Bureau of Highways and Street Cleaning.

OBITUARY

GORHAM H. HARTER, 61, retired, who was formerly engineer in charge of highway maintenance and construction in Erie, Niagara, and Broome counties in New York State, died May 27 at Herkimer, N. Y. Harter was a director and past president of the New York State Association of Highway Engineers.

ROBERT A. WALLACE, who practiced architecture in Buffalo for 43 years, died there on March 31 at the age of 65. Wallace was the architect on the Ward pumping station, power plants at Niagara Falls and Winnipeg, and many other public buildings. He was supervising architect of the Pan American Exposition and was for several years city architect. At the time of his death, he was consulting architect for the Norwich Engineering Co.

S. M. GIBBS, division engineer for the North Carolina State Highway and Public Works Commission, died April 2 at the age of 51. Gibbs, a specialist on asphalt roads, had been with the commission for the past 17 years.

ARTHUR L. LERCH, an engineer for the city of Lockport, N. Y., died there April 7 at the age of 70. Lerch was for many years a construction engineer for the American District Steam Company of North Tonawanda, N. Y.

HERBERT G. CLARK, assistant engineer in the city engineering department of Hartford, Conn., died April 6 at the age of 69. A graduate of Worcester Polytechnic Institute, Clark joined the city engineering staff in 1903.